USDA United States Department of Agriculture

Natural Resources Conservation Service

In cooperation with Missouri Department of Natural Resources and Missouri Agricultural Experiment Station

Soil Survey of Holt County, Missouri

How To Use This Soil Survey

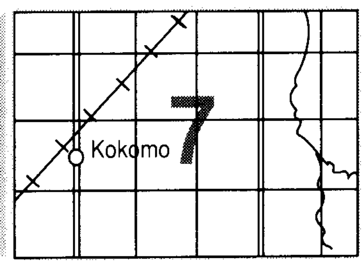
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

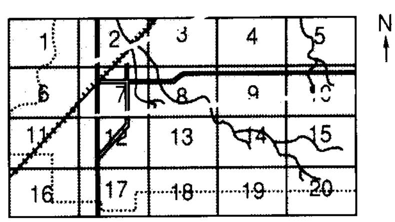
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



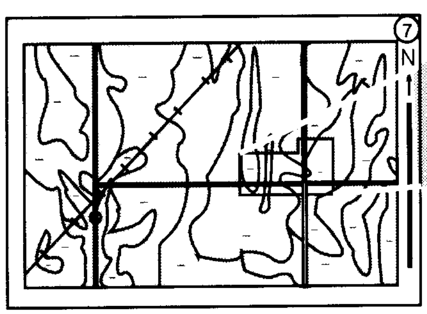
MAP SHEET

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.

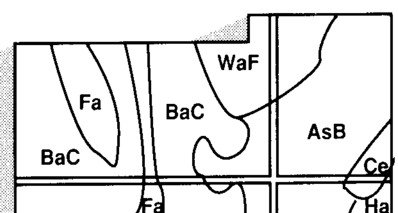


INDEX TO MAP SHEETS

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (formerly the Soil Conservation Service) has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1992. Soil names and descriptions were approved in 1993. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1992. This survey was made cooperatively by the Natural Resources Conservation Service, the Missouri Department of Natural Resources, and the Missouri Agricultural Experiment Station. It is part of the technical assistance furnished to the Holt County Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Natural Resources Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Snow geese in the Squaw Creek National Wildlife Refuge. An area of Timula-Hamburg silt loams, 14 to 90 percent slopes, is in the background.

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Issued November 1997

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Foreword

This soil survey contains information that can be used in land-planning programs in Holt County, Missouri. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

Roger A. Hansen
State Conservationist
Natural Resources Conservation Service

Soil Survey of Holt County, Missouri

By Donald Holbrook, Natural Resources Conservation Service

Fieldwork by Donald Holbrook, Tracy L. Smith, and Fred J. Young, Natural Resources Conservation Service, and Patricia Kowalewycz, Missouri Department of Natural Resources

United States Department of Agriculture, Natural Resources Conservation Service, in cooperation with the Missouri Department of Natural Resources and the Missouri Agricultural Experiment Station

HOLT COUNTY is in the northwest corner of Missouri (fig. 1). It has an area of 300,685 acres, or nearly 470 square miles. Oregon is the county seat, and Mound City is the largest town. Other towns include Craig, Corning, and Forest City. The population of Holt County was 6,034 in 1990.

Farming is the main enterprise in Holt County. The main crops are corn, soybeans, and small grain. Grasses and legumes also are produced for hay and pasture. The largest livestock enterprises are raising beef cattle and hogs and raising chickens for soup stocks.

Holt County is about 60 percent uplands and about 40 percent alluvial flood plains. The major management concern in the uplands is controlling erosion on sloping cropland. Flood control and soil water management are concerns on the flood plains.

This survey updates the soil survey of Holt County published in 1953 (Shrader and others, 1953). It provides more information and has larger maps, which show the soils in greater detail.

An area of Nebraska that is on the Missouri side of the Missouri River and that was not included in the soil survey of Richardson County, Nebraska, is included with this survey.

Figure 1.—Location of Holt County in Missouri.

General Nature of the County

This section provides general information concerning the county. It describes history and development; physiography, relief, and drainage; and climate.

History and Development

When Missouri was admitted to statehood in 1821, the northwestern part of the state, or the area that is

now Platte, Buchanan, Andrew, Holt, Atchison, and Nodaway Counties, was Indian territory. In 1836, William Clark of the Lewis and Clark Expedition, acting as agent for the Sac-and-Fox and Ioway Indian tribes, accepted $7,500 cash and 400 sections of land in Kansas in what was referred to as the Platte Purchase. Holt County was organized out of the Platte Purchase in 1841. It originally included Atchison County and part of Nodaway County. The presentday boundary was established in 1845 when Atchison and Nodaway Counties were separated from Holt County. The county was named for David R. Holt, who had been a Representative from Platte County to the State Legislature (Williams, 1915).

The first permanent settlers arrived in Holt County in 1838 from Parke County, Indiana, and settled about 5 miles southeast of the present town of Oregon. These settlers found ample timber and water supplies and productive soils. The first crops planted were much the same as those produced today; corn, wheat, barley, oats, alfalfa, and hemp were the main crops. Corn and wheat soon became the major crops. In the 1950's, however, soybeans became important and the acreages of corn and wheat declined.

The hills adjacent to the Missouri River flood plain were well suited to fruit crops, and large acreages of apples, peaches, pears, and grapes were planted. By 1850, more than 82,000 acres was used for crops and the average price of land was $2.56 an acre. There were more than 20,000 head of cattle, hogs, and sheep in the county (Williams, 1915).

The population of the area quickly increased. The population was about 500 in 1842; 6,550 in 1860; and 17,083 in 1900 (Williams, 1915). It began to decline soon after the Civil War.

The railroads played an important part in the development of the county by bringing in needed goods for development and opening markets for timber, livestock, and farm products. Work on the first railroad line was interrupted in the early 1860's by the Civil War, and a line that ran through the entire county was not completed until 1869. Lines run north from Andrew County along the flood plain through Forest City, Craig, and Corning and into Atchison County. A spur line was added in 1880 to Mound City and across the uplands into Nodaway County but has since been abandoned.

Artificial drainage of the Missouri River flood plains began in 1872, and in 1944 the Congressional Flood Act authorized the building of a system of levees along the river. Electric lights came to Holt County in 1895, and the telephone was introduced about 1900.

Physiography, Relief, and Drainage

Holt County is about 60 percent uplands and 40 percent flood plains. It is bounded on the west and south by the Missouri River, which flows south through the county. The flood plain along the Missouri River covers the entire western part of the county and is roughly 2 to 12 miles wide. The county is bounded on the north by Atchison and Nodaway Counties and on the east by the Nodaway River, which flows south along the entire eastern boundary and empties into the Missouri River below Forbes.

Between the Missouri and Nodaway Rivers are narrow, gently sloping and moderately sloping summits with strongly sloping to very steep side slopes dissected by small drainageways, which flow toward the larger streams. Steep hills rise abruptly as much as 250 feet above the flood plains. In the southern part of the county, along these steep hills, limestone and shale formations are exposed on the lower parts of the hillslopes. Most summits in the county are at elevations between 1,000 and 1,150 feet.

A divide approximately 1,100 feet in elevation extends across the entire county from north to south. About two-thirds of the uplands drains to the west directly into the Missouri River. The eastern one-third of the uplands drains into the Nodaway River, a tributary of the Missouri River. Other important Missouri River tributaries are the Big Tarkio River, Little Tarkio Creek, and Squaw Creek. These streams drain about 80 square miles of the uplands and then flow across the Missouri River flood plain in a southwesterly direction and empty into the Missouri River.

Climate

Table 1 gives data on temperature and precipitation for the survey area as recorded at Oregon in the period 1960 to 1990. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 29 degrees F and the average daily minimum temperature is 19 degrees. The lowest temperature on record is -25 degrees. In summer, the average temperature is 74 degrees and the average daily maximum temperature is 86 degrees. The highest recorded temperature is 107 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive

plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 35.99 inches. Of this, about 26 inches, or about 72 percent, usually falls in April through September. The growing season for most crops falls within this period. The heaviest 1-day rainfall during the period of record was 4.94 inches on September 10, 1986. Thunderstorms occur on about 51 days each year, and most occur in June.

The average seasonal snowfall is 18.8 inches. The heaviest 1-day snowfall on record is 8.5 inches. On the average, 28 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 81 percent. The sun shines 70 percent of the time possible in summer and 56 percent in winter. The prevailing wind is from the south-southeast. Average windspeed is highest, 13 miles per hour, in March.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the

significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

The descriptions, names, and delineations of the soils on the soil maps of this survey do not fully agree with those on the maps of adjacent surveys published at a different date. Differences are the result of additional soil data, variations in the intensity of mapping, and correlation decisions that reflect local conditions. In some areas, combining small acreages of similar soils that respond to use and management in much the same way is more practical than mapping these soils separately and giving them different names.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by two or three kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Consequently, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Thus, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

1. Leta-Grable-Haynie Association

Nearly level, somewhat poorly drained, somewhat excessively drained, and well drained, clayey, loamy, and silty soils that formed in alluvium; on low flood plains along the Missouri River

The soils in this association are in nearly level areas on low flood plains along the Missouri River. They are characterized by short, steep escarpments that run parallel to the river and separate this association from the high flood plains. Areas protected by levees are flooded only when the levees are broken or overtopped. Soils on the river side of the levees are frequently flooded. Some fields have been effectively drained by grade ditches leading to canals.

This association makes up about 14 percent of the survey area. It is about 53 percent Leta soils, 19 percent Grable soils, 13 percent Haynie soils, and 15 percent minor soils (fig. 2).

The somewhat poorly drained Leta soils are in broad, slightly concave areas. Typically, the surface layer and subsurface layer are very dark grayish brown, firm silty clay. The subsoil is dark grayish brown, mottled, very firm silty clay. The substratum is stratified, dark grayish brown, mottled, very friable silt loam and very fine sandy loam.

The somewhat excessively drained Grable soils are on broad, slightly convex natural levees on the flood plains. Typically, the surface layer is very dark grayish brown, very friable very fine sandy loam. The upper part of the substratum is grayish brown, dark grayish brown, and brown, mottled, very friable very fine sandy loam and silt loam. The lower part of the substratum is dark grayish brown, mottled, loose fine sand.

The well drained Haynie soils are on broad, slightly convex natural levees on the flood plains. Typically, the surface layer is very dark grayish brown, friable silt loam. The substratum is stratified brown, very dark brown, and dark brown, mottled, very friable silt loam.

Minor soils in this association are Gilliam, Luton, Kenmoor, Modale, and Sarpy soils. The somewhat poorly drained Gilliam soils are in slightly convex areas. They have a thicker dark surface layer than the major soils. The poorly drained Luton soils are in depressions. They are clayey to a depth of 60 inches. The moderately well drained Kenmoor soils are in the higher areas. They are made up of sandy material over clayey material. The somewhat poorly drained Modale soils are in the slightly lower areas. They are silt loam over silty clay. The excessively drained Sarpy soils are on convex bars. They are sandy throughout.

Most areas of this association are used for cultivated crops. Corn, soybeans, and winter wheat are the main crops. Grain sorghum is also grown, and a few small areas are used for alfalfa. Typically, woodland areas are adjacent to the Missouri River and provide habitat for deer and other wildlife species. Spilled grain from harvested fields also provides important feed for waterfowl during the fall migration. Hunting for deer and migratory waterfowl is an important recreational activity in areas of this association. Some landowners lease hunting rights to sportsmen during hunting seasons. Big Lake State Park and the H.F. Thurnau and Bob Brown Wildlife Areas are located within this association. One town and scattered farmsteads and grain storage bins

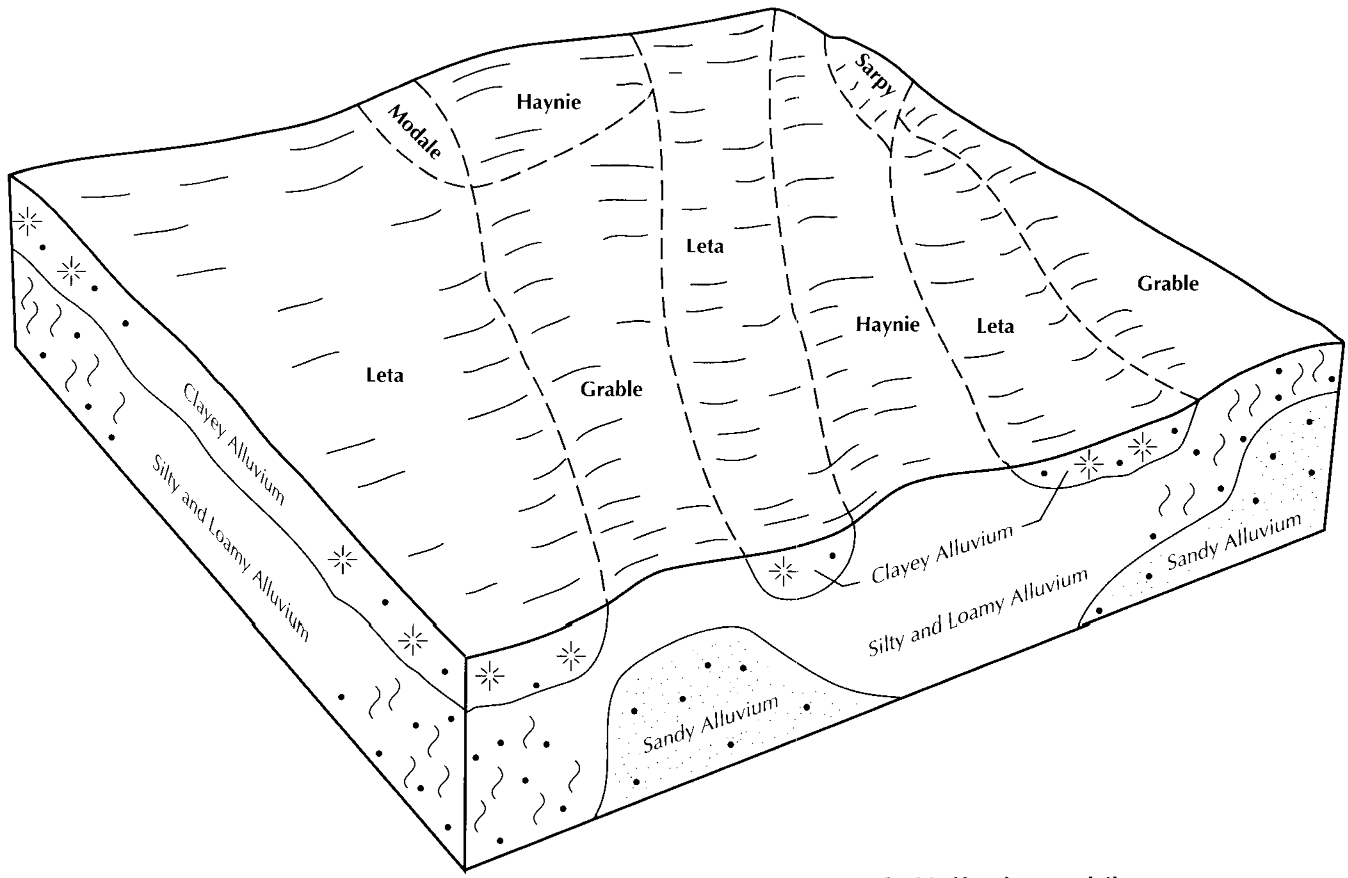

Figure 2.—Typical pattern of soils and parent material in the Leta-Grable-Haynie association.

are also in areas of this association.

The soils in this association are suited to cultivated crops, pasture, and hay if they are protected from flooding and wetness. Controlling flooding and wetness by maintaining levees and drainage ditches is the main management concern.

Soils on the river side of levees are not used for building site development or onsite waste disposal systems because of frequent flooding. The main management concerns in areas protected by levees are rare flooding, wetness, restricted permeability, the high shrink-swell potential of the Leta soils, and the poor filtering capacity of the Grable soils, which could result in the contamination of ground water.

2. Luton-Wabash-Blencoe Association

Nearly level, poorly drained and somewhat poorly drained, clayey soils that formed in alluvium; on high flood plains along the Missouri River

The soils in this association are in nearly level areas on high flood plains along the Missouri River. Areas protected by levees are subject to flooding if the levees are broken or overtopped. Many fields have been effectively drained by grade ditches leading to canals.

This association makes up about 18 percent of the survey area. It is about 43 percent Luton soils, 20 percent Wabash and similar soils, 18 percent Blencoe soils, and 19 percent minor soils.

The poorly drained Luton soils are in broad, slightly concave areas. Typically, the surface layer is very dark gray, very firm clay. The subsurface layer is very dark gray, mottled, very firm silty clay and clay. The subsoil is dark gray, mottled, very firm silty clay.

The poorly drained Wabash soils are in broad, slightly concave areas. Typically, the surface layer is black, very firm silty clay. The subsurface layer is black, mottled, very firm silty clay. The subsoil is very dark gray and dark gray, mottled, very firm clay.

The somewhat poorly drained Blencoe soils are in broad, slightly concave areas. Typically, the surface layer is black, firm silty clay. The subsurface layer is very dark grayish brown, mottled, firm silty clay and clay. The subsoil is dark grayish brown, mottled, firm

silty clay. The substratum is dark grayish brown and grayish brown, mottled, friable silt loam.

Minor soils in this association are Gilliam, Grable, Haynie, Leta, and Modale soils. The somewhat poorly drained Gilliam soils are in slightly convex areas. They have less clay throughout than the major soils. The somewhat excessively drained Grable and well drained Haynie soils are in slightly convex areas on old natural levees. Grable soils are silty in the upper part and sandy in the lower part. Haynie soils are silty throughout. The somewhat poorly drained Leta soils are in intermediate positions between low and high areas on the flood plain. They are calcareous throughout. The somewhat poorly drained Modale soils are adjacent to old natural levees. They are silty in the upper part and clayey in the lower part. They are calcareous throughout.

Most areas of this association are used for cultivated crops. Corn, soybeans, and winter wheat are the main crops. Grain sorghum also is grown, and a few small areas are used for alfalfa. The few scattered woodland areas are dominated by cottonwood and other water-tolerant species that provide habitat for deer and other wildlife species. Spilled grain from harvested fields also provides important feed for waterfowl during the fall migration. Hunting for deer and migratory waterfowl is an important recreational activity in areas of this association. Some landowners lease hunting rights to sportsmen during hunting seasons. The Squaw Creek National Wildlife Refuge is partially located within this association. Two towns and scattered farmsteads and grain storage bins are also in areas of this association.

The soils in this association are suited to cultivated crops, pasture, and hay if they are protected from flooding and wetness. Controlling flooding and wetness by maintaining levees and drainage ditches is the main management concern.

The soils in this association generally are not used for building site development or onsite waste disposal systems because of rare flooding, wetness, restricted permeability, and the shrink-swell potential.

3. Motark-Dupo-Dockery Association

Nearly level, moderately well drained and somewhat poorly drained, silty soils that formed in alluvium; on flood plains

The soils in this association are on flood plains along secondary streams that cross the Missouri River flood plain. Areas protected by levees are subject to flooding if the levees are broken or overtopped.

This association makes up about 7 percent of the survey area. It is about 31 percent Motark soils, 26 percent Dupo soils, 24 percent Dockery soils, and 19 percent minor soils.

The moderately well drained Motark soils are in broad, slightly convex areas. Typically, the surface layer is very dark grayish brown, very friable silt loam. The substratum is stratified dark grayish brown, brown, and grayish brown, mottled, very friable silt.

The somewhat poorly drained Dupo soils are in broad, slightly convex areas. Typically, the surface layer is very dark grayish brown, friable silt loam. The upper part of the substratum is stratified dark grayish brown, very dark grayish brown, and black, mottled, friable silt loam. The lower part is black, very firm clay.

The somewhat poorly drained Dockery soils are in the slightly lower convex areas. Typically, the surface layer is very dark brown, friable silt loam. The upper part of the substratum is stratified brown, black, and dark grayish brown, mottled, friable silt loam and silty clay loam. The lower part is black, very firm silty clay.

Minor soils in this association are Blencoe, Colo, Luton, Napier, and Wabash soils. The poorly drained Colo, Luton, and Wabash soils are in the lower areas. Colo soils are silty clay loam throughout, and Luton and Wabash soils are silty clay or clay throughout. The somewhat poorly drained Blencoe soils are in the lower areas. They are silty clay in the upper part and silt loam in the lower part. The well drained Napier soils are on alluvial fans and foot slopes adjacent to the uplands. They are silt loam throughout.

Most areas of this association are used for cultivated crops. Corn, soybeans, and winter wheat are the main crops. Grain sorghum also is grown, and a few small areas are used for alfalfa. Spilled grain from harvested fields provides important feed for waterfowl during the fall migration. Hunting of migratory waterfowl is an important recreational activity in areas of this association. Some landowners lease hunting rights to sportsmen during hunting seasons. The Squaw Creek National Wildlife Refuge is partially located within this association. One town and scattered farmsteads and grain storage bins are also in this association.

The soils in this association are suited to cultivated crops, pasture, and hay if they are protected from flooding and wetness. Controlling flooding and wetness by maintaining levees and drainage ditches is the main management concern.

This association generally is not used for building site development or onsite waste disposal systems because of rare flooding and wetness.

4. Timula-Monona-Napier Association

Very gently sloping to steep, well drained, silty soils that formed in loess and slope alluvium; on uplands and foot slopes

The soils in this association are on very dissected, narrow, branching ridgetops, on steep gullied side slopes, and on the lower foot slopes adjacent to the Missouri River flood plain. Many drainageways are deeply incised and have little or no flood plain.

This association makes up about 7 percent of the survey area. It is about 52 percent Timula and similar soils, 14 percent Monona and similar soils, 11 percent Napier soils, and 23 percent minor soils.

Timula soils are on side slopes. Typically, the surface layer is very dark grayish brown and dark brown, friable silt loam. The subsoil and substratum are brown, friable silt loam.

Monona soils are on ridgetops and side slopes. Typically, the surface layer is black, friable silt loam. The subsurface layer is very dark grayish brown and dark brown, friable silt loam. The subsoil is dark yellowish brown, friable silt loam in the upper part and dark yellowish brown, mottled, friable silt loam in the lower part. The substratum is yellowish brown, mottled, friable silt loam.

Napier soils are on foot slopes and alluvial fans dissected by steep drainageways. Typically, the surface layer and the subsurface layer are very dark grayish brown, friable silt loam. The subsoil is dark brown, friable silt loam.

Minor soils in this association are the somewhat excessively drained Hamburg soils. These soils are on very steep or nearly vertical side slopes. They have less clay throughout than the major soils.

Most areas of this association are woodland. The main tree species are white oak, northern red oak, black oak, sugar maple, and shagbark hickory. Commercial timber harvesting is limited, however, and this association is used mainly for wildlife habitat and recreation. Some of the narrow ridgetops, valleys, and side slopes are cultivated. Corn and soybeans are the main crops. Alfalfa, grain sorghum, and winter wheat also are grown. Some of the less sloping areas support permanent pasture. Fall hunting of deer and game birds is a major recreational use. The Jamerson C. McCormack and Monkey Mountain Conservation Areas and the River Breaks State Forest are located within this association. Two towns and scattered farmsteads and grain storage bins are also in this association.

The soils in this association generally are not used for cultivated crops because of the very severe hazard of erosion. Also, many areas are too steep for the establishment of hayland. The slope also poses a safety hazard affecting the operation of machinery.

The major soils in this association generally are not used for building site development or onsite waste disposal systems because of the slope. The narrow ridgetops and foot slopes are somewhat suited to these uses.

5. Nodaway-Colo Association

Nearly level, moderately well drained and poorly drained, silty soils that formed in alluvium; on secondary flood plains

The soils in this association are on flood plains along secondary streams. Some areas are protected by levees but are subject to flooding if the levees are breached. Unprotected areas are subject to occasional flooding.

This association makes up about 4 percent of the survey area. It is about 59 percent Nodaway soils, 36 percent Colo soils, and 5 percent minor soils.

The moderately well drained Nodaway soils are in nearly level, slightly convex areas adjacent to stream channels. Typically, the surface layer is very dark grayish brown, friable silt loam. The substratum is stratified dark grayish brown, black, very dark brown, and brown, mottled, friable silt loam and firm silty clay loam.

The poorly drained Colo soils are in nearly level or slightly concave areas. Typically, the surface layer is black, friable silty clay loam. The subsurface layer is black, mottled, friable silty clay loam. The subsoil is black, mottled, firm silty clay loam.

Minor soils in this association are Judson and Wabash soils. The well drained Judson soils are on foot slopes. The poorly drained Wabash soils are in the slightly lower areas. They have more clay throughout than the major soils.

Most areas of this association are used for cultivated crops. Corn, soybeans, and winter wheat are the main crops. Grain sorghum also is grown, and a few small areas are used for alfalfa. Small woodland areas along the main channels and in the branching drainageways are used as wildlife habitat. There are no towns and only a few farmsteads in areas of this association. Fall hunting of game birds and deer is a recreational use.

The soils in this association are suited to cultivated crops, pasture, and hay if they are protected from flooding and wetness.

The soils in this association are unsuited to building site development and onsite waste disposal systems because of the occasional flooding.

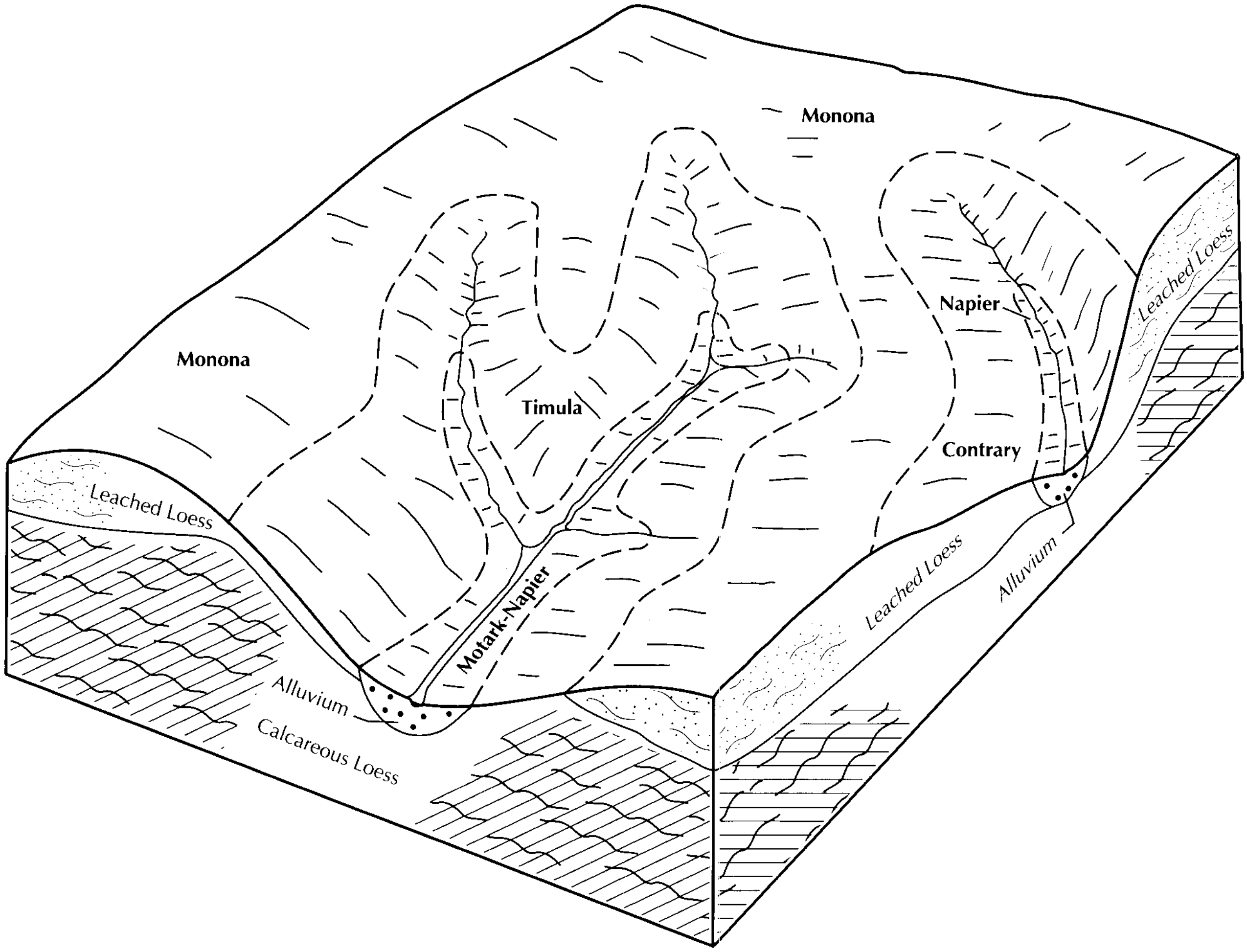

Figure 3.—Typical pattern of soils and parent material in the Monona-Timula-Contrary association.

6. Monona-Timula-Contrary Association

Gently sloping to moderately steep, well drained, silty soils that formed in loess; on uplands

The soils in this association are on narrow and moderately wide, elongated ridgetops and side slopes dissected by narrow, branching drainageways.

This association makes up about 11 percent of the survey area. It is about 35 percent Monona soils, 20 percent Timula soils, 13 percent Contrary soils, and 32 percent minor soils (fig. 3).

Monona soils are on ridgetops and side slopes. Typically, the surface layer is black, friable silt loam. The subsurface layer is very dark grayish brown and dark brown, friable silt loam. The subsoil is dark yellowish brown, friable silt loam. It is mottled in the lower part. The substratum is yellowish brown, mottled, friable silt loam.

Timula soils are on side slopes. Typically, the surface layer is very dark grayish brown and dark brown, friable silt. The subsoil and substratum are brown, mottled, friable silt loam.

Contrary soils are on side slopes, mostly in the eastern part of the association. Typically, the surface layer is dark brown, friable silt loam. The subsoil is dark yellowish brown, yellowish brown, and grayish brown, mottled, friable silt loam. The substratum is grayish brown, mottled, very friable silt loam.

Minor soils in this association are Judson, Motark, Napier, and Nodaway soils. Judson and Napier soils are on foot slopes. The moderately well drained Motark and Nodaway soils are on flood plains. They are stratified below the surface layer.

Most areas of this association are used for cultivated crops, pasture, and hay. Corn, soybeans, and winter wheat are the main crops. Grain sorghum also is grown,

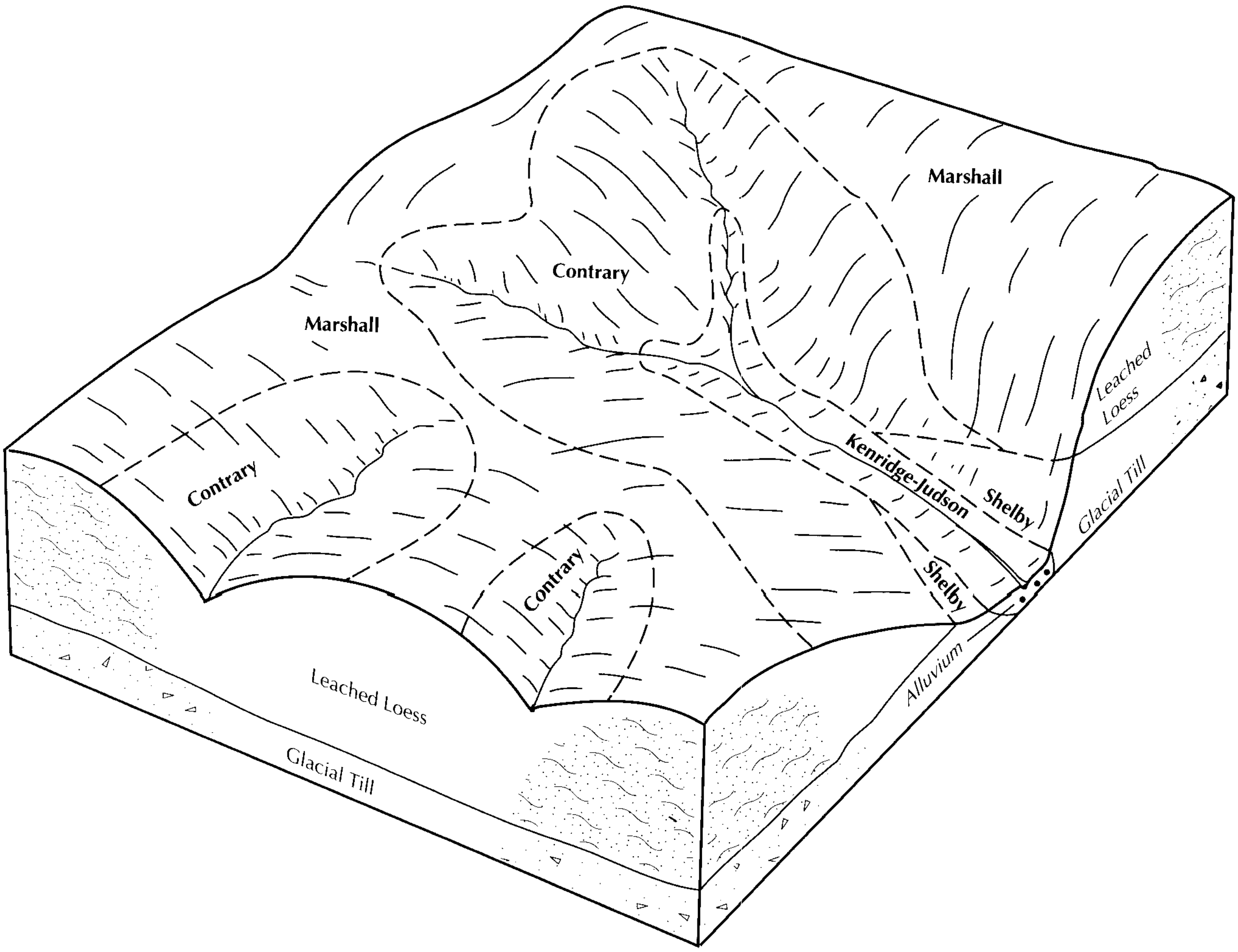

Figure 4.—Typical pattern of soils and parent material in the Marshall-Contrary association.

and a few small areas are used for alfalfa. Some of the steeper areas in the westernmost part of the association are used for woodland, wildlife habitat, or seasonal hunting of game birds and deer. One town and many scattered farmsteads are located in this association.

Most areas of this association are suited to cultivated crops, pasture, and hay. The hazard of erosion and soil piping are the main management concerns. The severely eroded Timula soils on slopes of more than 14 percent generally are not used for cultivated crops because of the severe hazard of further erosion.

Most areas of this association are suited to building site development and onsite waste disposal systems. The main limitation is the slope. The Timula soils that have slopes of more than 15 percent generally are not used for sanitary facilities or building site development.

7. Marshall-Contrary Association

Gently sloping to strongly sloping, well drained, silty soils that formed in loess; on uplands

The soils in this association are on narrow and moderately wide, elongated ridgetops and side slopes dissected by narrow, branching drainageways.

This association makes up about 11 percent of the survey area. It is about 50 percent Marshall soils, 33 percent Contrary soils, and 17 percent minor soils (fig. 4).

Marshall soils are on ridgetops and side slopes. Typically, the surface layer is very dark brown, friable silty clay loam. The subsurface layer is very dark grayish brown, friable silty clay loam. The subsoil is dark yellowish brown, firm silty clay loam in the upper part and dark yellowish brown, mottled, friable silty clay loam in the lower part.

Contrary soils are on side slopes. Typically, the surface layer is dark brown, friable silt loam. The subsoil is dark yellowish brown, yellowish brown, and grayish brown, mottled, friable silt loam. The substratum is grayish brown, mottled, very friable silt loam.

Minor soils in this association are Exira, Judson, Kenridge, Nodaway, and Shelby soils. Exira soils are on side slopes. They have mottles in the upper part of the subsoil. The moderately well drained Kenridge and Nodaway soils are on flood plains. Kenridge soils have a very thick, dark surface layer. Nodaway soils are stratified below the surface layer. Judson soils are on foot slopes. They have a very thick, dark surface layer. The moderately well drained Shelby soils are on the lower side slopes. They contain glacial sand and gravel.

Most areas of this association are used for cultivated crops. Corn, soybeans, and winter wheat are the main crops. Grain sorghum also is grown, and a few small areas are used for alfalfa. Some areas support permanent pasture. A few small woodland areas are mainly along drainageways in 5- to 30-acre tracts. There are no towns located in areas of this association, but there are many scattered farmsteads. Seasonal hunting of game birds and deer is a recreational use of the association.

The soils in this association are suited to cultivated crops, pasture, and hay. The hazard of erosion is the main management concern.

The major soils in this association are suited to building site development and onsite waste disposal systems. The slope and the shrink-swell potential are the main limitations.

8. Marshall-Exira-Shelby Association

Gently sloping to strongly sloping, well drained and moderately well drained, silty and loamy soils that formed in loess and glacial till; on uplands

The soils in this association are on narrow and moderately wide, elongated ridgetops and side slopes dissected by narrow, branching drainageways.

This association makes up about 20 percent of the survey area. It is about 25 percent Marshall soils, 24 percent Exira soils, 21 percent Shelby soils, and 30 percent minor soils (fig. 5).

The well drained Marshall soils are on ridgetops, side slopes, and stream terraces in stream valleys. Typically, the surface layer is very dark brown, friable silty clay loam. The subsurface layer is very dark grayish brown, friable silty clay loam. The subsoil is dark yellowish brown, firm silty clay loam in the upper part and dark yellowish brown, mottled, friable silty clay loam in the lower part.

The well drained Exira soils are on side slopes below the Marshall soils. Typically, the surface layer is very dark brown, friable silty clay loam. The subsoil is brown, mottled, firm silty clay loam. The substratum is grayish brown, mottled silt loam.

The moderately well drained Shelby soils are on side slopes below the Exira soils. Typically, the surface layer is very dark grayish brown, firm clay loam. The subsoil is brown and yellowish brown, mottled, firm clay loam. The substratum is light brownish gray, mottled, firm clay loam.

Minor soils in this association are Judson, Kenridge, and Lamoni soils. Judson soils are on foot slopes adjacent to the uplands. Kenridge soils are on flood plains. The somewhat poorly drained Lamoni soils are on side slopes above the Shelby soils. They have fewer pebbles and cobbles throughout than the major soils.

The soils in this association are used mainly for cultivated crops. Corn, soybeans, and winter wheat are the main crops. Grain sorghum also is grown, and a few small areas are used for alfalfa. There are a few areas of pasture and hayland, but the overall acreage is small. A few small tracts of woodland are mainly along drainageways in 5- to 30-acre tracts. One town and many scattered farmsteads are located in areas of this association. Seasonal hunting of game birds and deer is a recreational use of the association.

The soils in this association are suited to cultivated crops, small grain, and grasses and legumes. The hazard of erosion is the main management concern.

The major soils in this association are suitable for building site development and onsite waste disposal systems. The slope is a limitation in the steeper areas. The restricted permeability and the shrink-swell potential are limitations in areas of the Shelby soils.

9. Knox-Vanmeter Association

Moderately sloping to very steep, well drained and moderately well drained, silty soils that formed in loess and in loess and colluvium; on uplands

The soils in this association are on highly dissected, narrow, branching ridgetops and steep, gullied side slopes adjacent to the flood plains along the Missouri and Nodaway Rivers. Most drainageways are deeply incised and have narrow flood plains or no flood plain.

This association makes up about 8 percent of the survey area. It is about 53 percent Knox soils, 30 percent Vanmeter soils, and 17 percent minor soils.

The well drained Knox soils are on ridgetops and side slopes. Typically, the surface layer is brown, friable silty clay loam. The subsoil is dark yellowish brown, firm silty clay loam and friable silt loam. The substratum is brown, friable silt loam.

The moderately well drained Vanmeter soils are on

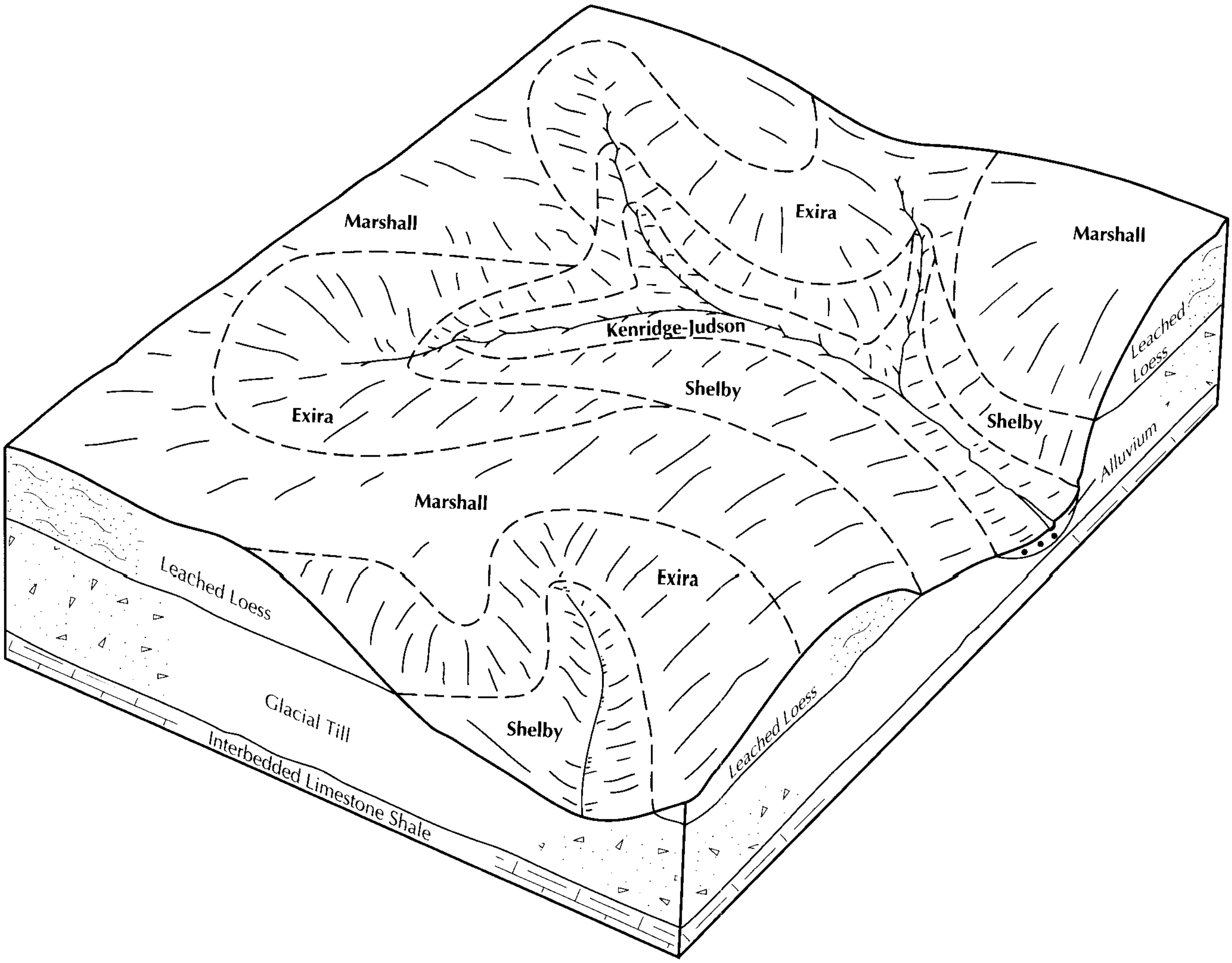

Figure 5.—Typical pattern of soils and parent material in the Marshall-Exira-Shelby association.

side slopes. Typically, the surface layer is very dark grayish brown, friable flaggy silt loam. The subsoil is yellowish brown and light olive brown, firm silty clay loam and silty clay. The underlying material is light olive brown and grayish brown, soft, weathered shale.

Minor soils in this association are Judson, Napier, Nodaway, and Timula soils. Judson and Napier soils are on foot slopes. They have a very thick, dark surface layer. The moderately well drained Nodaway soils are on flood plains. They are stratified below the surface layer. Timula soils are in the lower positions on side slopes. They are calcareous in the subsoil and have less clay throughout than the major soils.

Most areas of this association are used for woodland, wildlife habitat, or recreation. The main tree species are white oak, northern red oak, black oak, sugar maple, and shagbark hickory. Seasonal hunting of deer and game birds is a major recreational use of the association. The soils in the less sloping areas are used for cultivated crops or for pasture. Corn, soybeans, and winter wheat are the main crops. Grain sorghum and alfalfa also are grown. Two wildlife refuges and two towns are partially located in this association.

The soils in this association generally are not used for cultivated crops because of the slope and a severe hazard of erosion. The soils in the less sloping areas are suited to cultivated crops, pasture, and hay. The hazard of erosion is the main management concern.

The major soils generally are not used for building site development or onsite waste disposal systems

because of the slope and the depth to bedrock and because of the restricted permeability and a high shrink-swell potential in the Vanmeter soils. The less sloping areas of the Knox soils are best suited to building site development and onsite waste disposal systems. The slope is the main management concern.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under the heading "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Marshall silty clay loam, 2 to 5 percent slopes, is a phase of the Marshall series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Kenridge-Judson complex, 1 to 7 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, quarries, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

14—Blencoe silty clay, rarely flooded. This very deep, nearly level, somewhat poorly drained soil is on high flood plains along the Missouri River. The soil is protected by levees but is subject to flooding if the levees are broken or overtopped. Individual areas are irregular in shape and range from about 80 to 900 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 10 inches, black, firm silty clay

Subsurface layer:
10 to 20 inches, very dark grayish brown, mottled, firm silty clay

Subsoil:
20 to 28 inches, dark grayish brown, mottled, firm silty clay

Substratum:
28 to 60 inches, dark grayish brown and grayish brown, mottled, friable silt loam

In places the substratum is very fine sandy loam.

Included with this soil in mapping are areas of Luton soils. These soils are clayey to a depth of 60 inches. They are in the slightly lower areas. They make up about 10 percent of the unit.

Important properties of the Blencoe soil—

Permeability: Slow in the upper part, moderate in the lower part
Surface runoff: Very slow
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: High in the upper part, moderate in the lower part
Depth to the water table: 1.5 to 3.0 feet

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The main management concern is wetness. Open ditches, shallow surface drains, and land grading help to remove excess water. Some areas have been effectively drained. In these areas, maintaining the present drainage system is needed for the efficient removal of excess water. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the spring. If this soil is tilled when wet, the seedbed becomes cloddy and cannot be easily managed. Tilling only when the soil is at the proper moisture content helps to minimize compaction and the formation of clods. Conservation tillage practices improve tilth in the surface layer. Returning crop residue and other organic material to the surface layer improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to grasses and legumes for pasture. The main limitation is the wetness. Species that are tolerant of wetness, such as alsike clover, ladino clover, tall fescue, smooth brome, orchardgrass, and reed canarygrass, are best suited to this soil. Warm-season grasses, such as eastern gamagrass, switchgrass, and big bluestem, are well suited. Controlling grazing in wet areas helps to minimize compaction and helps to maintain a good sod cover. The soil generally is not used for hay crops because of the wetness. Surface drains and field ditches help to remove excess surface water.

This soil generally is not used for building site development or onsite waste disposal systems because of the flooding, the wetness, the high shrink-swell potential, and the restricted permeability. Levee failure and flooding are also possible. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the potential for frost action, the shrink-swell potential, and the flooding are severe limitations if this soil is used as a site for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength and by shrinking and swelling of the soil. Grading the roads and streets so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to minimize the damage caused by frost action and wetness. Roads and streets should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification is IIw. No woodland ordination symbol is assigned.

15G—Vanmeter flaggy silt loam, 14 to 45 percent slopes. This moderately deep, moderately well drained, moderately steep or steep soil is on side slopes in the uplands that border the flood plains along the Missouri River and its tributaries. Individual areas are irregular in shape and range from about 40 to 450 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 7 inches, very dark grayish brown, friable flaggy silt loam

Subsoil:
7 to 10 inches, yellowish brown, firm silty clay loam
10 to 22 inches, light olive brown, firm silty clay

Bedrock:
22 to 60 inches, light olive brown, soft shale

In some places the surface layer does not contain flagstones. In other places the surface layer has more than 35 percent flagstones.

Included with this soil in mapping are small areas of Knox, Napier, and Shelby soils. These soils are more than 60 inches deep to bedrock. The well drained Knox soils do not have flagstones. They are on side slopes above and on benches below the Vanmeter soil. The well drained Napier soils are on foot slopes. They have a very thick, dark surface layer. Shelby soils are on back slopes above the Vanmeter soil and below the Knox soils. They contain glacial sand and gravel. Also included, in areas directly above the Vanmeter soil, are ledges of limestone rock outcrops; bands of soils that average more than 35 percent limestone flagstones in the upper 40 inches; and abandoned small rock quarries. Included areas make up about 15 percent of the unit.

Important properties of the Vanmeter soil—

Permeability: Very slow
Surface runoff: Rapid or very rapid
Available water capacity: Low
Organic matter content: Moderately low
Shrink-swell potential: High

Depth to the water table: More than 6 feet

Most areas are woodland. The main tree species are white oak, northern red oak, black oak, sugar maple, and shagbark hickory. Commercial timber harvest is limited, however, and this soil is used mainly for wildlife habitat or recreation. A few of the less sloping areas are used for pasture, hay, or crops.

This soil is unsuited to cultivated crops because of the severe hazard of erosion. Converting cropland to permanent vegetative cover, such as pasture, can help to prevent further erosion.

Only the areas that have slopes of less than about 25 percent are suited to pasture renovation. These areas are suited to most commonly grown grasses and legumes, such as alfalfa, reed canarygrass, smooth brome, tall fescue, eastern gamagrass, indiangrass, big bluestem, and switchgrass. Care is needed when pastures are reestablished because of the severe hazard of erosion. Pastures should be renovated only when necessary for the maintenance of production. Plants should be established in strips that follow the contour. Plowing and cultivation should be avoided. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to trees. Equipment limitations and the erosion hazard are management concerns. The slope limits the use of equipment and increases the hazard of erosion. As the slope gradient increases, using wheeled equipment becomes more difficult. On the steeper slopes, track type equipment should be used. In the steepest areas, even track type equipment cannot be used safely. In these areas it may be necessary to yard the logs uphill with cables. The number of suitable landing sites is very limited. Tree planting may be restricted to hand planting in areas where the slope is more than 35 percent. Constructing water bars and out-sloping road surfaces, adding culverts and drop structures, creating riparian buffer strips, seeding exposed areas, and locating haul roads and skid trails on the contour or on the gentler slopes help to prevent excessive soil loss.

This soil generally is not used for building site development or onsite waste disposal systems because of the depth to weathered bedrock, the high shrink-swell potential, the restricted permeability, and the slope. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the high shrink-swell potential, the potential for frost action, and the slope are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads and streets so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action.

The land capability classification is VIIe. The woodland ordination symbol is 2R.

16—Colo silty clay loam, occasionally flooded. This very deep, nearly level, poorly drained soil is on flood plains. Some areas are protected by levees. Individual areas are irregular in shape and range from about 30 to 450 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 9 inches, black, friable silty clay loam

Subsurface layer:
9 to 27 inches, black, mottled, friable silty clay loam

Subsoil:
27 to 60 inches, black and very dark gray, mottled, firm silty clay loam

In some places the surface layer is silt loam.

Included with this soil in mapping are small areas of Judson and Nodaway soils. The well drained Judson soils are on foot slopes adjacent to the uplands. The moderately well drained Nodaway soils are on natural levees adjacent to stream channels. Included soils make up about 10 percent of the unit.

Important properties of the Colo soil—

Permeability: Moderate
Surface runoff: Very slow
Available water capacity: High
Organic matter content: High
Shrink-swell potential: Moderate
Depth to the water table: 1 to 3 feet

Most areas are used for cultivated crops. A few areas are used for pasture and hay. This soil is suited to corn, soybeans, and small grain. The main management concerns are wetness and flooding. Open ditches, shallow surface drains, and land grading help to remove excess water. Some areas have been effectively drained. In these areas, maintaining the drainage system is needed for the efficient removal of excess water. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the spring. Restricting fieldwork when the soil is wet helps to prevent compaction and cloddiness. In areas that are not protected by levees, planting and harvesting can be delayed and crop yields may be reduced in some years. Diversions can be used to protect some areas from excess runoff but generally are

not needed. Using a system of conservation tillage, planting cover crops, and returning crop residue to the surface layer improve fertility and tilth and increase the rate of water infiltration.

This soil is suited to grasses and legumes for pasture. The main limitations are the wetness and the flooding. Species that are tolerant of wetness, such as alsike clover, ladino clover, reed canarygrass, tall fescue, smooth brome, and orchardgrass, are best suited to this soil. Warm-season grasses, such as eastern gamagrass, switchgrass, and big bluestem, are well suited. Controlling grazing during flooding periods helps to minimize compaction and helps to maintain a good sod cover. Sedimentation during flooding reduces forage yields and may kill plants in some areas. Hay crops do not grow well on this soil. Drainage can be improved by surface laterals and field ditches.

This soil is unsuited to building site development and onsite waste disposal systems because of the flooding. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

The land capability classification is IIw. No woodland ordination symbol is assigned.

18B—Kenridge-Judson complex, 1 to 7 percent slopes. This map unit consists of very deep, very gently sloping and moderately sloping soils on narrow flood plains and foot slopes. The moderately well drained Kenridge soil is on the narrow flood plains and is subject to occasional flooding. The well drained Judson soil is on foot slopes adjacent to the flood plain. The proportions of the soils in the unit vary, ranging from about 35 to 55 percent for each soil. The Kenridge soil is dominant in the larger drainageways, and the Judson soil is dominant in the smaller drainageways. Individual areas of this map unit are very long, narrow, and branching and range from about 200 to 1,400 acres in size. The soils are in narrow bands and could not be mapped separately at the scale used.

The typical sequence, depth, and composition of the layers of the Kenridge soil are as follows—

Surface layer:
0 to 8 inches, very dark brown, friable silty clay loam

Subsurface layer:
8 to 45 inches, black, firm silty clay loam

Subsoil:
45 to 60 inches, very dark gray, firm silty clay loam

In places the surface layer is silt loam.

Important properties of the Kenridge soil—

Permeability: Moderately slow
Surface runoff: Slow
Available water capacity: Very high
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: 3 to 5 feet

The typical sequence, depth, and composition of the layers of the Judson soil are as follows—

Surface layer:
0 to 8 inches, very dark brown, friable silt loam

Subsurface layer:
8 to 24 inches, very dark grayish brown, friable silt loam

Subsoil:
24 to 60 inches, dark brown, firm silty clay loam

Important properties of the Judson soil—

Permeability: Moderate
Surface runoff: Medium
Available water capacity: Very high
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

Included with these soils in mapping are steep to nearly vertical streambanks and gullies 5 to 30 feet deep. These areas make up less than 10 percent of the unit. Also included are small areas of Nodaway soils that are closer to the stream channel than the major soils. Nodaway soils have a thinner dark surface layer than the major soils. In the northern part of the survey area are small areas of well drained, loamy soils on foot slopes. These loamy soils contain alluvial glacial sand and pebbles. Included areas make up about 10 percent of the unit.

Most areas of the Kenridge and Judson soils are used for cultivated crops, pasture, or hay. A narrow strip on both sides of most drainageways is overgrown with trees and brush and is used for wildlife habitat. These soils are suited to corn, soybeans, and small grain. The main management concerns are occasional flooding and streambank erosion on the Kenridge soil and a hazard of erosion on the Judson soil. Also, because of the steep streambanks, many areas cannot be crossed with farm equipment. Flooding can delay planting and harvesting in some years and may reduce crop yields. Maintaining a filter strip of permanent vegetation along the edges of the stream channel helps to protect the stream from sedimentation and helps to stabilize streambanks. The hazard of erosion can be reduced on the Judson soil by using a conservation tillage system that leaves a protective cover of crop residue on the surface, planting winter cover crops, and farming on the contour. Diversions can be used to

protect areas from upland runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

These soils are suited to most commonly grown grasses and legumes, such as ladino clover, red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and switchgrass. The main limitations are the occasional flooding on the Kenridge soil and the hazard of erosion on the Judson soil during seedbed preparation. Deferring grazing immediately after flooding helps to minimize compaction and helps to maintain a good sod cover. Sedimentation during flooding reduces forage yields and may kill plants in some areas. Erosion can be minimized by preparing the seedbed on the contour and by timing tillage so that a good ground cover is quickly established.

The Kenridge soil is unsuited to building site development and onsite waste disposal systems because of the flooding, the wetness, and the restricted permeability. Dwellings and septic tank absorption fields should be constructed in areas of the more favorable Judson soil. No major limitations affect dwellings or septic tank absorption fields on the Judson soil.

The flooding, low strength, and the potential for frost action are limitations on sites for local roads and streets on the Kenridge soil. Low strength and the potential for frost action are limitations on the Judson soil. Roads should be constructed on raised, well compacted fill material above known flood levels. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action.

The land capability classification of the Kenridge soil is IIw, and that of the Judson soil is IIe. No woodland ordination symbol is assigned.

20D2—Contrary silt loam, 9 to 14 percent slopes, eroded. This very deep, strongly sloping, well drained soil is on side slopes in the uplands. Some of the original dark surface soil has eroded away. The present surface layer has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to 1,200 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 5 inches, dark brown, friable silt loam

Subsoil:
5 to 24 inches, dark yellowish brown and yellowish brown, mottled, friable silt loam
24 to 46 inches, grayish brown, mottled, friable silt loam

Substratum:
46 to 60 inches, grayish brown, mottled, very friable silt loam

In some places terrace construction has removed as much as 2 feet of soil material and has exposed the substratum. In other places the dark surface layer is as much as 10 inches thick. In some areas the subsoil has less clay and is more calcareous.

Included with this soil in mapping are small areas of Judson, Napier, and Shelby soils. The moderately well drained Judson and Napier soils are on foot slopes. They have a very thick, dark surface layer. The moderately well drained Shelby soils are on the lower side slopes below the Contrary soil. They contain glacial sand and gravel. Included soils make up about 10 percent of the unit.

Important properties of the Contrary soil—

Permeability: Moderate
Surface runoff: Rapid
Available water capacity: Very high
Organic matter content: Moderate
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are used for pasture and hay. This soil is suited to corn, soybeans, and small grain. The main management concern is erosion. Most areas can be terraced and farmed on the contour. Installing either broad-base terraces or terraces that have steep back slopes along with suitable outlets helps to manage runoff and thus helps to control erosion (fig. 6). Soil piping can be a problem if proper construction techniques are not used when underground tile outlets are installed for terraces. Constructing grassed waterways helps to control erosion in drainageways, and the waterways provide an outlet for terrace drains. Conservation tillage practices conserve moisture, help to maintain tilth, and minimize the damage caused by the impact of raindrops. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion.

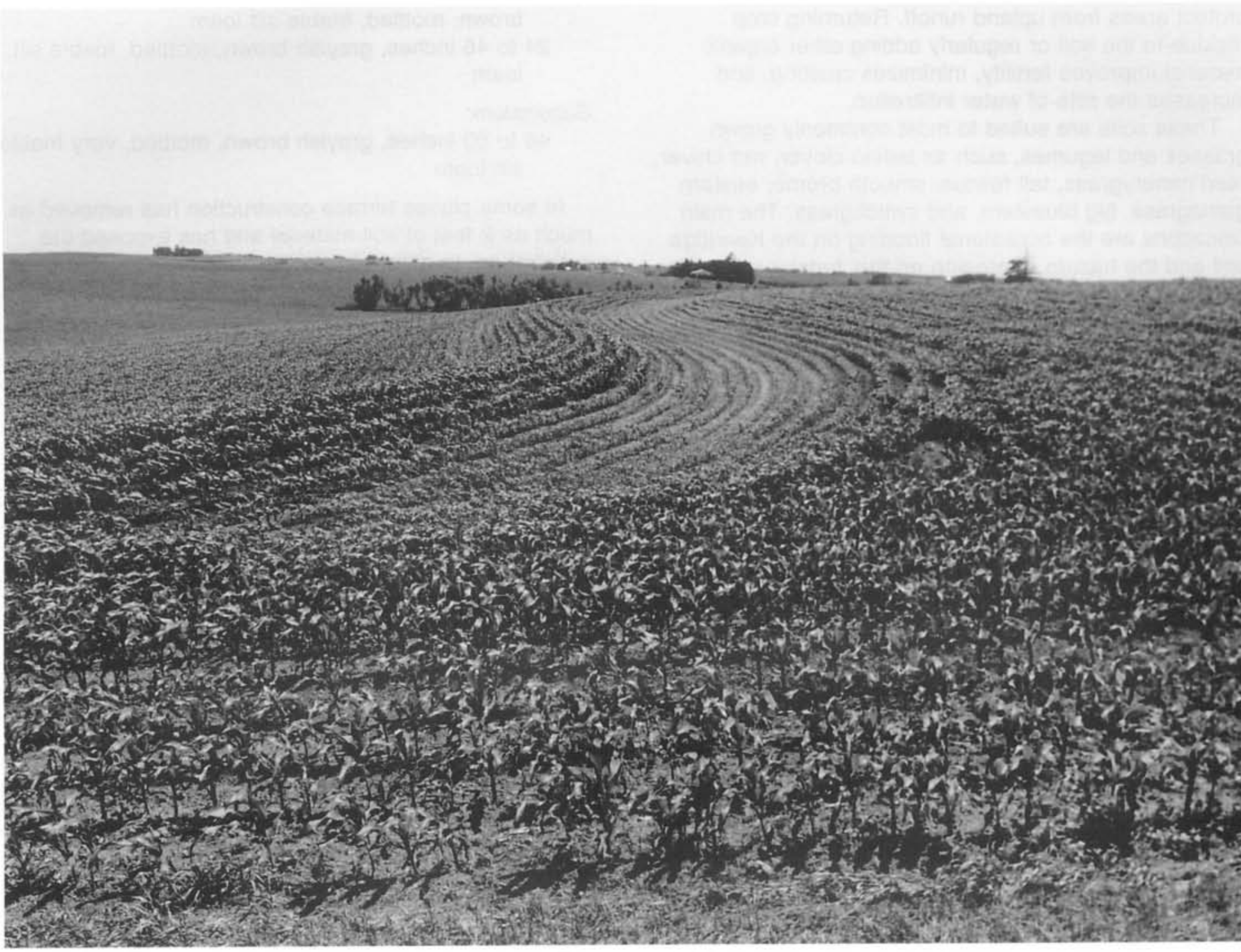

Figure 6.—A broad-base terrace in an area of Contrary silt loam, 9 to 14 percent slopes, eroded.

Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to building site development and septic tank absorption fields. It is limited by the slope. Dwellings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping. Land shaping and installing the distribution lines across the slope are necessary for the proper functioning of septic tank absorption fields.

Low strength, the potential for frost action, and the slope are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by frost action. Roads and streets can be designed so that they conform to the natural contour of the land. Some cut and fill may be necessary because of the slope.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

22—Dockery silt loam, clayey substratum, rarely flooded. This very deep, nearly level, somewhat poorly drained soil is on high flood plains along the Missouri River. Most areas are protected by levees but are subject to flooding from high-level floods if the levees

break or are overtopped. Individual areas are irregular in shape and range from about 30 to 300 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 9 inches, very dark brown, friable silt loam

Substratum:
9 to 49 inches, stratified black, brown, and dark grayish brown, mottled, friable silt loam and silty clay loam
49 to 60 inches, black, very firm silty clay

In some places the surface layer is loam or silty clay loam. In other places thin layers of fine sandy loam, loam, or sandy loam are below the surface layer.

Included with this soil in mapping are small areas of Colo, Motark, and Wabash soils. The poorly drained Colo soils are in the slightly lower areas. They have a very thick, dark surface layer. The moderately well drained Motark soils are in the slightly higher areas. They are silt loam to a depth of 60 inches. The poorly drained Wabash soils are in depressions. They are silty clay to a depth of 60 inches. Included soils make up about 10 percent of the unit.

Important properties of the Dockery soil—

Permeability: Moderate in the upper part, very slow in the lower part
Surface runoff: Very slow
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: Moderate in the upper part, high in the lower part
Depth to the water table: 2 to 3 feet

Most areas are used for cultivated crops. A few areas are used for pasture and hay. This soil is suited to corn, soybeans, and small grain. The main management concern is wetness. Open ditches and shallow surface drains help to remove excess water. Some areas have been effectively drained. In these areas, maintaining the present drainage system is needed for the efficient removal of excess water. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the spring. Conservation tillage practices conserve moisture and help to maintain tilth. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to grasses and legumes for pasture and hay. The main limitation is the wetness. Ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, eastern gamagrass, switchgrass, big bluestem, and indiangrass are best suited to this soil. Surface drains and field ditches help to remove excess surface water. Controlling grazing in wet areas helps to minimize compaction and helps to maintain a good sod cover.

This soil is suited to trees. No major limitations affect timber management. Many areas are suited to year-round forestry activities, except during periods when the soil is saturated. Most conventional harvesting and planting methods can be used. Nutrient supplies and the water-holding capacity are good.

This soil generally is not used for building site development or onsite waste disposal systems because of the flooding and the wetness. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the potential for frost action, the wetness, and the flooding are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by frost action and wetness. Roads and streets should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification is IIw. The woodland ordination symbol is 4A.

26—Grable very fine sandy loam, frequently flooded. This very deep, nearly level, somewhat excessively drained soil is on low flood plains along the Missouri River between the levee and the river channel. The soil is frequently flooded for brief or long periods. Individual areas are irregular in shape and range from 10 to 300 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 8 inches, very dark grayish brown, very friable very fine sandy loam

Substratum:
8 to 18 inches, brown, very friable very fine sandy loam
18 to 60 inches, brown, loose fine sand

In places the surface layer is silt loam.

Included with this soil in mapping are areas of Haynie and Sarpy soils. The well drained Haynie soils are slightly lower on the landscape than the Grable soil. They are silt loam and very fine sandy loam throughout. The excessively drained Sarpy soils are sandy throughout. They are on the higher narrow convex bars. Included soils make up about 15 percent of the unit.

Important properties of the Grable soil—

Permeability: Moderate in the upper part, rapid in the lower part
Surface runoff: Very slow
Available water capacity: Moderate
Organic matter content: Moderately low
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are wooded and are used for wildlife habitat or recreation. This soil is suited to corn, soybeans, and small grain. The main management concerns are flooding, wind erosion, and the available water capacity. Flooding can delay planting and harvesting and reduce crop yields in some years. Conservation tillage practices that maintain crop residue on the surface conserve moisture and help to minimize the damage caused by wind erosion. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and switchgrass. The main limitation is the flooding. Grazing management should be designed around possible flooding periods. Sedimentation during flooding can reduce forage yields and may kill plants in some areas.

This soil is unsuited to building site development and onsite waste disposal systems because of the flooding. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

The land capability classification is IIw. No woodland ordination symbol is assigned.

27—Grable-Leta complex, rarely flooded. This map unit consists of the very deep, nearly level, somewhat excessively drained Grable soil and the somewhat poorly drained Leta soil. These soils are on low flood plains along the Missouri River. The Grable soil is in the higher areas between swales, and the Leta soil is in the swales. The soils are protected by levees but are subject to flooding if the levees are broken or overtopped. This unit is about 70 percent Grable soil and 15 percent Leta soil. Individual areas are irregular in shape and range from about 350 to 1,900 acres in size. The soils are in narrow bands and could not be mapped separately at the scale used.

The typical sequence, depth, and composition of the layers of the Grable soil are as follows—

Surface layer:
0 to 8 inches, very dark grayish brown, very friable very fine sandy loam

Substratum:
8 to 24 inches, stratified brown and yellowish brown, mottled, very friable very fine sandy loam and silt loam
24 to 40 inches, brown, mottled, loose loamy fine sand
40 to 60 inches, stratified brown, loose loamy very fine sand and very fine sandy loam

In places the surface layer is silt loam.

Important properties of the Grable soil—

Permeability: Moderate in the upper part, rapid in the next part, moderately rapid in the lower part
Surface runoff: Very slow
Available water capacity: Moderate
Organic matter content: Moderately low
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

The typical sequence, depth, and composition of the layers of the Leta soil are as follows—

Surface layer:
0 to 8 inches, black, very firm silty clay

Subsurface layer:
8 to 18 inches, black, mottled, very firm silty clay

Subsoil:
18 to 33 inches, very dark grayish brown and dark grayish brown, mottled, very firm silty clay

Substratum:
33 to 60 inches, stratified grayish brown, very friable very fine sandy loam

Important properties of the Leta soil—

Permeability: Slow in the upper part, moderate in the lower part
Surface runoff: Very slow
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: High in the upper part, low in the lower part
Depth to the water table: 1 to 3 feet

Included with these soils in mapping are small areas of Haynie and Sarpy soils and areas on the river side of the levee that are frequently flooded. The well drained Haynie soils are in the same landscape positions as the Grable soil. They are silt loam and very fine sandy loam throughout. The excessively drained Sarpy soils are on the higher narrow convex bars. They are sandy throughout. Also included are small areas of very poorly drained soils in swales that are subject to ponding. The soils in these areas are variable but are stratified with textures ranging from sand to clay. Included areas

make up about 15 percent of the unit.

Most areas of the Grable and Leta soils are used for cultivated crops. These soils are suited to corn, soybeans, and small grain. The main management concerns are wind erosion and summer droughtiness on the Grable soil and wetness on the Leta soil. Conservation tillage practices that maintain crop residue on the surface conserve moisture and help to minimize the damage caused by wind erosion. Open ditches and shallow surface drains help to remove excess water on the Leta soil. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the spring. If the Leta soil is tilled when it is wet, the seedbed becomes cloddy and cannot be easily managed. Tilling only when the soil is at the proper moisture content helps to minimize compaction and the formation of clods. Also, conservation tillage practices improve tilth in the surface layer. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

The Grable soil is suited to most commonly grown grasses and legumes, such as alfalfa, red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and switchgrass. The main limitation is the flooding. Grazing management should be designed around possible flooding periods. Sedimentation during flooding can reduce forage yields and may kill plants in some areas. The Leta soil is suited to grasses and legumes for pasture. The main limitation is the wetness. Species that are tolerant of wetness, such as alsike clover, ladino clover, tall fescue, smooth brome, orchardgrass, and reed canarygrass, are best suited to this soil. Warm-season grasses, such as eastern gamagrass, switchgrass, and big bluestem, are well suited. Controlling grazing in wet areas helps to minimize compaction and helps to maintain a good sod cover. The Leta soil generally is not used for hay crops because of the wetness. Surface drains and field ditches help to remove excess surface water.

These soils are suited to trees. No major concerns affect woodland management on the Grable soil. Equipment limitations and seedling mortality are management concerns on the Leta soil. Clayey soils have insufficient traction, low strength, and a moderate seedling mortality rate and can easily become compacted during wet periods. Ruts form easily on haul roads and skid trails. These trails may be impassable during rainy periods. Logging activities should be restricted to dry periods or to surfaced areas. Seedling establishment can be enhanced by using mechanical or chemical weed-control methods, providing shade, mulching, or providing supplemental water. Planting containerized stock that has well developed root systems also improves the seedling survival rate.

These soils generally are not used for building site development or onsite waste disposal systems because of the wetness, the restricted permeability of the Leta soil, and the risk of ground-water contamination caused by a poor filtering capacity in the Grable soil. Levee failure and flooding are also possible. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the shrink-swell potential, the potential for frost action, the wetness, and the flooding limit the use of these soils as sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling, wetness, and frost action. Roads should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification of the Grable soil is IIs, and that of the Leta soil is IIw. No woodland ordination symbol is assigned for the Grable soil. The woodland ordination symbol of the Leta soil is 7C.

28—Gilliam silt loam, rarely flooded. This very deep, nearly level, somewhat poorly drained soil is on flood plains along the Missouri River. The soil is protected by levees but is subject to flooding if the levees are broken or overtopped. Individual areas are irregular in shape and range from about 30 to 1,400 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:

0 to 12 inches, very dark grayish brown, friable silt loam

Substratum:

12 to 23 inches, dark grayish brown, mottled, friable silt loam

23 to 43 inches, stratified dark grayish brown and brown, mottled, firm silty clay loam and silt loam

43 to 60 inches, stratified grayish brown and dark grayish brown, mottled, friable silt loam

Included with this soil in mapping are areas of Blencoe and Haynie soils. Also included, on the river side of the levee, are Gilliam soils that are frequently flooded. Blencoe soils are in slight depressional areas. They are clayey in the upper part. The well drained Haynie soils have a thinner dark surface layer than the Gilliam soil and have less clay throughout. They are in

the slightly higher areas. Included soils make up about 10 percent of the unit.

Important properties of the Gilliam soil—

Permeability: Moderate
Surface runoff: Very slow
Available water capacity: Very high
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: 1.5 to 3.0 feet

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The main management concern is wetness. Open ditches and shallow surface drains help to remove excess water. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the spring. Conservation tillage practices improve tilth in the surface layer. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to grasses and legumes for pasture and hay. The main limitation is the wetness. Ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, eastern gamagrass, switchgrass, big bluestem, and indiangrass are best suited to this soil. Surface drains and field ditches help to remove excess surface water. Controlling grazing in wet areas helps to minimize compaction and helps to maintain a good sod cover.

This soil is suited to trees. No major concerns affect timber management. Many areas are suited to year-round forestry activities, except during periods when the soil is saturated. Most conventional harvesting and planting methods can be used. Nutrient supplies and the available water capacity are good.

This soil generally is not used for building site development or onsite waste disposal systems because of the wetness and the flooding. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the shrink-swell potential, the wetness, the potential for frost action, and the flooding are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength and by shrinking and swelling of the soil. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and minimize the damage caused by wetness and by frost action. Roads and streets should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification is IIw. The woodland ordination symbol is 4A.

29—Grable very fine sandy loam, rarely flooded. This very deep, nearly level, somewhat excessively drained soil is on low flood plains along the Missouri River. The soil is protected by levees but is subject to flooding if the levees are broken or overtopped. Individual areas are irregular in shape and range from about 20 to 800 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 8 inches, very dark grayish brown, very friable very fine sandy loam

Substratum:
8 to 21 inches, grayish brown, mottled, very friable very fine sandy loam
21 to 30 inches, stratified brown, dark grayish brown, and grayish brown, mottled, very friable silt loam
30 to 60 inches, dark grayish brown, mottled, loose fine sand

In places the surface layer is silt loam.

Included with this soil in mapping are areas of Haynie and Sarpy soils. The well drained Haynie soils are slightly lower on the landscape than the Grable soil. They are silt loam and very fine sandy loam throughout. The excessively drained Sarpy soils are sandy throughout. They are on the higher narrow convex bars. Included soils make up about 15 percent of the unit.

Important properties of the Grable soil—

Permeability: Moderate in the upper part, rapid in the lower part
Surface runoff: Very slow
Available water capacity: Moderate
Organic matter content: Moderately low
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The main management concerns are wind erosion and the available water capacity. Conservation tillage practices that maintain crop residue on the surface conserve moisture and help to prevent the damage caused by wind erosion. Also, returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and switchgrass. The main limitation is flooding. Grazing management should be designed around possible flooding periods.

Sedimentation during flooding can reduce forage yields and may kill plants in some areas.

This soil generally is not used for building site development or onsite waste disposal systems because of the flooding and a poor filtering capacity, which can result in the contamination of ground water. Dwellings and waste disposal systems should be constructed in areas of more favorable soils.

The flooding and low strength are limitations on sites for local roads and streets. Roads and streets should be constructed on raised, well compacted fill material above known flood levels. Adding crushed rock or other suitable base material minimizes the damage caused by low strength.

The land capability classification is IIs. No woodland ordination symbol is assigned.

30—Haynie silt loam, frequently flooded. This very deep, nearly level, well drained soil is on low flood plains along the Missouri River between levees and the river channel. The soil is subject to flooding for very brief periods. Individual areas are irregular in shape and range from 10 to 450 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 8 inches, very dark grayish brown, friable silt loam

Substratum:
8 to 21 inches, stratified brown and dark grayish brown, mottled, friable silt loam
21 to 60 inches, stratified brown and dark grayish brown, mottled, very friable silt loam and very fine sandy loam with thin strata of loamy sand and silty clay

In some places this soil has thin layers of coarser and finer textured material throughout the profile. In other places the surface layer is very fine sandy loam.

Included with this soil in mapping are areas of Grable, Leta, and Sarpy soils. The somewhat excessively drained Grable soils are slightly higher on the landscape than the Haynie soil. They are sandy in the lower part of the substratum. The somewhat poorly drained Leta soils are in the lower areas. They are clayey in the upper part. Sarpy soils are on the higher narrow convex bars. They are sandy throughout. Included soils make up about 15 percent of the unit.

Important properties of the Haynie soil—

Permeability: Moderate
Surface runoff: Very slow
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are wooded and are used for wildlife habitat or recreation. This soil is suited to corn, soybeans, and small grain. The main management concern is flooding, which can delay planting and harvesting and may reduce crop yields in some years. Returning crop residue and other organic material to the surface layer improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as ladino clover, red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and switchgrass. The main limitation is the flooding. Grazing management should be designed around possible flooding periods. Sedimentation during flooding can reduce forage yields and may kill plants in some areas.

This soil is suited to trees. No major concerns affect timber management. Many areas are suited to year-round forestry activities, except during periods when the soil is saturated. Most conventional harvesting and planting methods can be used. Nutrient supplies and the water-holding capacity are good.

This soil is unsuited to building site development and onsite waste disposal systems because of the frequent flooding. Dwellings and onsite waste disposal systems should be constructed in areas of more favorable soils.

The land capability classification is IIIw. The woodland ordination symbol is 11A.

32—Haynie silt loam, rarely flooded. This very deep, nearly level, well drained soil is on low flood plains along the Missouri River. The soil is protected by levees but is subject to flooding from high-level floods if the levees break or are overtopped. Individual areas are irregular in shape and range from about 10 to 450 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 8 inches, very dark grayish brown, friable silt loam

Substratum:
8 to 60 inches, layers of brown, very dark brown, and dark brown, mottled, friable silt loam

In some places this soil has thin layers of coarser and finer textured material throughout the profile. In other places the surface layer is very fine sandy loam.

Included with this soil in mapping are areas of Grable, Leta, and Sarpy soils. The somewhat

excessively drained Grable soils are slightly higher on the landscape than the Haynie soil. They are sandy in the lower part of the substratum. The somewhat poorly drained Leta soils are clayey in the upper part and loamy in the lower part. They are in the lower areas. The excessively drained Sarpy soils are on the higher narrow convex bars. They are sandy throughout. Included soils make up about 15 percent of the unit.

Important properties of the Haynie soil—

Permeability: Moderate
Surface runoff: Very slow
Available water capacity: Very high
Organic matter content: Moderate
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. Limitations affecting crops are slight. Returning crop residue and other organic material to the surface layer improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as ladino clover, red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and switchgrass. No major limitations or hazards affect pasture and hayland.

This soil is suited to trees. No major concerns affect timber management. Many areas are suited to year-round forestry activities, except during periods when the soil is saturated. Most conventional harvesting and planting methods can be used. Nutrient supplies and the water-holding capacity are good.

This soil generally is not used for dwellings or onsite waste disposal systems because of the flooding. Dwellings and onsite waste disposal systems should be constructed in areas of more favorable soils.

Low strength, the potential for frost action, and the flooding are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by frost action. Roads and streets should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification is I. The woodland ordination symbol is 11A.

34D2—Exira silty clay loam, 9 to 14 percent slopes, eroded. This very deep, strongly sloping, well drained soil is on concave head slopes and side slopes. Much of the original dark surface soil has eroded away. Individual areas are irregular in shape and range from about 10 to 850 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 7 inches, very dark brown, friable silty clay loam

Subsurface layer:
7 to 10 inches, very dark brown, friable silty clay loam

Subsoil:
10 to 36 inches, brown, mottled, firm silty clay loam

Substratum:
36 to 60 inches, grayish brown, mottled, friable silt loam

In some places terrace construction has removed as much as 2 feet of soil material and has exposed the substratum. In other places the dark surface layer is less than 10 inches thick. In some areas slopes are less than 9 percent.

Included with this soil in mapping are areas of Lamoni and Shelby soils. These soils are on side slopes below the Exira soil. They contain glacial sand and gravel. Lamoni soils are somewhat poorly drained, and Shelby soils are moderately well drained. Also included, on head slopes, are small areas of somewhat poorly drained soils that are not as gray in the upper part of the subsoil as the Exira soil. Included soils make up about 10 percent of the unit.

Important properties of the Exira soil—

Permeability: Moderate
Surface runoff: Rapid
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are used as pasture or hayland. This soil is suited to corn, soybeans, and small grain. The main management concern is erosion. Most areas can be terraced and farmed on the contour. Installing either broad-base terraces or terraces that have steep back slopes along with suitable outlets helps to manage runoff and thus helps to control erosion. Constructing grassed waterways helps to control erosion in drainageways and provides an outlet for terrace drains. During times of high precipitation, seeps can form on the lower slopes. These seeps generally do not limit agricultural activities. Conservation tillage practices conserve moisture, maintain tilth, and minimize the

damage caused by the impact of raindrops. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to building site development and onsite waste disposal. The construction of dwellings is limited by the shrink-swell potential and the slope. Constructing footings, foundations, and basement walls with adequately reinforced concrete and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling of the soil. Dwellings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping. Properly constructed septic tank absorption fields function adequately if their design can compensate for the slope and the restricted permeability. Installing the distribution lines across the slope and altering the slope by land shaping are necessary for the proper functioning of the absorption field.

Low strength, the shrink-swell potential, and the potential for frost action are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts for drainage minimize the damage caused by shrinking and swelling and by frost action. Roads can be designed so that they conform to the natural slope of the land. Some cut and fill may be necessary because of the slope.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

36B—Timula silt loam, 2 to 7 percent slopes. This very deep, gently sloping and moderately sloping, well drained soil is on side slopes in the uplands adjacent to the flood plain along the Missouri River. It is in areas where soil material has been excavated and used for fill material. Most remaining areas have been leveled and are used for cultivated crops. Individual areas are irregular in shape and range from about 5 to 40 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 7 inches, brown, very friable silt loam

Substratum:
7 to 19 inches, yellowish brown, very friable silt loam
19 to 60 inches, yellowish brown, mottled, very friable silt loam

Included with this soil in mapping are areas where excavation has removed most of the overlying loess material and has exposed the underlying glacial till. The soils in these areas are redder than the Timula soil and have more clay throughout. They make up about 15 percent of the unit.

Important properties of the Timula soil—

Permeability: Moderate
Surface runoff: Medium
Available water capacity: Very high
Organic matter content: Moderately low
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are used for pasture and hay. This soil is suited to corn, soybeans, and small grain. The main management concern is erosion. Some areas are large enough to be terraced. If underground tile outlets are installed for terraces, soil piping can be a problem unless proper construction techniques and maintenance are used. The hazard of erosion can be reduced by using a conservation tillage system that leaves a protective cover of crop residue on the surface, planting cover crops, and farming on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to trees. No major concerns affect

timber management. Many areas are suited to year-round forestry activities, except during periods when the soil is saturated. Most conventional harvesting and planting methods can be used. Nutrient supplies and the water-holding capacity are good.

This soil is suited to building site development and septic tank absorption fields if proper design and installation procedures are used. The slope and the restricted permeability are the main limitations. Sites for dwellings and septic tank absorption fields can be designed so that they conform to the natural landscape, or the slope can be modified by grading. Enlarging the absorption fields helps to compensate for the restricted permeability.

The potential for frost action is a limitation on sites for local roads and streets. Grading the roads and streets so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by frost action.

The land capability classification is IIe. The woodland ordination symbol is 4A.

36D3—Timula silt loam, 9 to 14 percent slopes, severely eroded. This very deep, strongly sloping, well drained soil is on side slopes in the uplands. Erosion has removed most of the original surface soil. The present surface layer has been mixed with the upper part of the substratum. Individual areas are irregular in shape and range from about 10 to 450 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 5 inches, brown, friable silt loam

Subsoil:
5 to 14 inches, brown, mottled, friable silt loam

Substratum:
14 to 60 inches, mottled grayish brown, strong brown, and yellowish brown, very friable silt loam

In places the soil is noncalcareous above a depth of 40 inches and has more clay.

Included with this soil in mapping are areas of Napier soils. These soils are on foot slopes. They have a very thick, dark surface layer. They make up about 10 percent of the unit.

Important properties of the Timula soil—

Permeability: Moderate
Surface runoff: Rapid
Available water capacity: Very high
Organic matter content: Moderately low
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are used as pasture or hayland. This soil is suited to cultivated crops. The main management concern is erosion. Most areas can be terraced and farmed on the contour. Installing either broad-base terraces or terraces that have steep back slopes along with suitable outlets helps to control erosion. Also, constructing grassed waterways helps to control erosion in drainageways and provides an outlet for terrace drains. If underground tile outlets for terraces are installed, soil piping can be a problem unless proper construction techniques and maintenance are used. Conservation tillage practices conserve moisture, maintain tilth, and minimize the damage caused by the impact of raindrops. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to trees. No major concerns affect timber management. Many areas are suited to year-round forestry activities, except during periods when the soil is saturated. Most conventional harvesting and planting methods can be used. The nutrient supply and available water capacity are good.

This soil is suited to building site development and septic tank absorption fields. It is limited by the slope and the restricted permeability. Dwellings can be designed so that they conform to the natural slope of the land, or the sites can be graded to an acceptable slope. Land shaping and installing longer distribution lines across the slope are necessary for the proper functioning of the absorption field.

The potential for frost action and the slope are limitations on sites for local roads and streets. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by frost action. Roads and streets can be designed so that they conform to the natural slope of the land. Some cut and fill may be necessary because of the slope.

The land capability classification is IVe. The woodland ordination symbol is 4A.

36E3—Timula silt loam, 14 to 25 percent slopes, severely eroded. This very deep, moderately steep and steep, well drained soil is on side slopes in the uplands. Erosion has removed most of the original surface soil. The present surface layer has been mixed with the upper part of the substratum. Individual areas are irregular in shape and range from about 10 to 100 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 4 inches, dark brown, friable silt loam

Substratum:
4 to 60 inches, dark yellowish brown and yellowish brown, friable silt loam

In places the soil is noncalcareous above a depth of 40 inches and has more clay.

Included with this soil in mapping are areas of Napier soils. These soils are on foot slopes. They have a very thick, dark surface layer. They make up about 10 percent of the unit.

Important properties of the Timula soil—

Permeability: Moderate
Surface runoff: Rapid
Available water capacity: Very high
Organic matter content: Moderately low
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops, pasture, or hayland. A few areas are used as woodland. This soil generally is unsuited to cultivated crops because of the severe hazard of further erosion. Converting cropland to permanent vegetative cover, such as pasture, can help to prevent further erosion in these areas.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to trees. Equipment limitations and the erosion hazard are major management concerns. The slope limits the use of equipment and increases the hazard of erosion. As the slope gradient increases, the use of wheeled equipment becomes more difficult. On the steeper slopes, track type equipment may be necessary. Constructing water bars and out-sloping road surfaces, adding culverts and drop structures, creating riparian buffer strips, seeding exposed areas, and building logging roads and skid trails on the contour or on the gentler slopes help to prevent excessive soil loss.

This soil generally is not used for building site development or onsite waste disposal systems because of the slope. Dwellings and septic tank systems should be constructed in areas of more favorable soils.

The slope and the potential for frost action are limitations on sites for local roads and streets. Cut and fill generally are necessary to adjust the slopes to an acceptable grade. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by frost action.

The land capability classification is VIe. The woodland ordination symbol is 4R.

40—Kenmoor-Grable complex, rarely flooded. This map unit consists of very deep, nearly level soils on low flood plains along the Missouri River. The Kenmoor soil is moderately well drained, and the Grable soil is well drained. The soils are protected by levees but are subject to flooding if the levees are broken or overtopped. The Kenmoor soil is slightly lower on the landscape than the Grable soil. This map unit is about 55 percent Kenmoor soil and 30 percent Grable soil. Individual areas are irregular in shape and range from about 15 to 120 acres in size. The soils are in narrow bands and could not be mapped separately at the scale used.

The typical sequence, depth, and composition of the layers of the Kenmoor soil are as follows—

Surface layer:
0 to 10 inches, dark grayish brown, very friable fine sandy loam

Substratum:
10 to 27 inches, layers of brown and pale brown, mottled, loose loamy fine sand
27 to 60 inches, very dark grayish brown and dark grayish brown, mottled, very firm silty clay

In some places the surface layer is loamy fine sand. In other places the depth to the clayey layer is less than 20 inches.

Important properties of the Kenmoor soil—

Permeability: Rapid in the upper part, slow in the lower part
Surface runoff: Very slow
Available water capacity: Moderate

Organic matter content: Low
Shrink-swell potential: Low in the upper part, high in the lower part
Depth to the water table: 2.5 to 3.0 feet

The typical sequence, depth, and composition of the layers of the Grable soil are as follows—

Surface layer:
0 to 8 inches, very dark grayish brown, very friable very fine sandy loam

Substratum:
8 to 24 inches, stratified dark grayish brown and yellowish brown, very friable very fine sandy loam with thin strata of silt loam and silty clay loam
24 to 35 inches, brown, loose loamy fine sand
35 to 60 inches, stratified brown, loose loamy very fine sand and very fine sandy loam

In places the surface layer is silt loam.

Important properties of the Grable soil—

Permeability: Moderate in the upper part, rapid in the next part, moderately rapid in the lower part
Surface runoff: Very slow
Available water capacity: Moderate
Organic matter content: Moderate
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

Included with these soils in mapping are small areas of Haynie and Sarpy soils. The well drained Haynie soils are slightly lower on the landscape than the Grable soil. They are silt loam and very fine sandy loam throughout. The excessively drained Sarpy soils are on narrow convex bars. They are sandy throughout. Also included are soils that are stratified throughout with textures ranging from loamy sand to silty clay and some small areas on the river side of the levee that are frequently flooded. Included areas make up about 15 percent of the unit.

Most areas of the Kenmoor and Grable soils are used for cultivated crops. These soils are suited to corn, soybeans, and small grain. The main management concerns are summer droughtiness and wind erosion. Conservation tillage practices that maintain crop residue on the surface conserve moisture and help to prevent the damage caused by wind erosion. Returning crop residue and other organic material to the soil improves fertility and conserves moisture.

These soils are suited to most commonly grown grasses and legumes, such as red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and switchgrass. The main limitation is the flooding. Controlling grazing during periods of flooding helps to minimize compaction and helps to maintain a good sod cover. Sedimentation during flooding can reduce forage yields and may kill plants in some areas.

These soils are suited to trees. Equipment limitations and seedling mortality are management concerns on the Kenmoor soil. Sandy soils have inadequate traction, and ruts can form easily when the soils are dry. Logging roads may require suitable surfacing for extended use. Because of droughtiness, the seedling mortality rate is high. Planting container-grown seedlings, reinforcement planting, planting when the soil is wet, and using special site preparation, such as furrowing or irrigation, increase the seedling survival rate. Windblown sand may also damage young seedlings. Harvest methods that leave some mature trees to provide shade and protection may be desirable. No major concerns affect woodland management on the Grable soil. Many areas are suited to year-round forestry activities, except during periods when the soil is saturated. Most conventional harvesting and planting methods can be used. Nutrient supplies and the water-holding capacity are good.

These soils generally are not used for building site development or onsite waste disposal systems because of the wetness, the restricted permeability, and the shrink-swell potential of the Kenmoor soil and the poor filtering capacity of the Grable soil. Levee failure and flooding are also possible. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

The flooding and the potential for frost action are limitations if the Kenmoor soil is used as a site for local roads and streets. Roads and streets should be constructed on raised, well compacted fill material above known flood levels. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by frost action.

The land capability classification of the Kenmoor soil is IIIs, and that of the Grable soil is IIs. The woodland ordination symbol of the Kenmoor soil is 4S. No woodland ordination symbol is assigned for the Grable soil.

42C2—Knox silty clay loam, 5 to 9 percent slopes, eroded. This very deep, moderately sloping, well drained soil is on ridgetops in the uplands. Much of the original surface soil has eroded away. The present surface layer has been mixed with the upper part of the subsoil. Individual areas are mostly long, narrow, and branching and range from about 5 to 250 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 8 inches, dark brown, friable silty clay loam

Subsoil:
8 to 47 inches, dark yellowish brown, firm silty clay loam

Substratum:
47 to 60 inches, brown, mottled, friable silt loam

In some places the surface layer is silt loam. In other places slopes are less than 5 percent.

Included with this soil in mapping are small areas of Shelby and Vanmeter soils on secondary ridgetops and in saddles. The moderately well drained Shelby soils have glacial sand and gravel. The moderately well drained Vanmeter soils are moderately deep over weathered bedrock. Included soils make up about 5 percent of the unit.

Important properties of the Knox soil—

Permeability: Moderate
Surface runoff: Medium
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

This soil is used for cultivated crops, pasture, or hayland. It is suited to corn, soybeans, and small grain. The main management concern is further erosion. Most areas are on narrow ridgetops and must be managed separately from adjacent side slopes that generally are not used for cultivated crops because of the slope. These areas are too narrow to be terraced, but the hazard of erosion can be reduced by using a conservation tillage system that leaves a protective cover of crop residue on the surface, planting cover crops, and farming on the contour. In areas that can be terraced, either broad-base terraces or terraces that have steep back slopes can be constructed. Suitable outlets are also needed. Constructing grassed waterways helps to control erosion in drainageways and provides an outlet for terrace drains. Conservation tillage practices conserve moisture, maintain tilth, and minimize the damage caused by the impact of raindrops. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to trees. No major concerns affect timber management. Many areas are suited to year-round forestry activities, except during periods when the soil is saturated. Most conventional harvesting and planting methods can be used. The nutrient supply and the water-holding capacity are good.

This soil is suited to building site development and septic tank absorption fields. The construction of dwellings without basements is limited by the shrink-swell potential. Constructing footings, foundations, and basement walls with adequately reinforced concrete and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Septic tank absorption fields function adequately if proper design and installation procedures are used.

Low strength, the shrink-swell potential, and the potential for frost action are limitations on sites for local roads and streets. Adding crushed rock or other suitable material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action.

The land capability classification is IIIe. The woodland ordination symbol is 4A.

42D2—Knox silty clay loam, 9 to 14 percent slopes, eroded. This very deep, strongly sloping, well drained soil is on side slopes in the uplands. Much of the original dark surface soil has eroded away. The present surface layer has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 5 to 90 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 6 inches, dark brown, friable silty clay loam

Subsoil:
6 to 32 inches, brown, firm silty clay loam

Substratum:
32 to 40 inches, brown, mottled, friable silt loam
40 to 60 inches, grayish brown, friable silt loam

In some places the surface layer is silt loam. In other places terrace construction has removed as much as 2 feet of soil material and has exposed the subsoil. In some areas the subsoil is grayer and has less clay.

Included with this soil in mapping are areas of

Judson, Shelby, and Vanmeter soils. Judson soils are on foot slopes. They have a very thick, dark surface layer. The moderately well drained Shelby soils are on side slopes below the Knox soil. They contain glacial sand and gravel. The moderately well drained Vanmeter soils are moderately deep over weathered bedrock and have more clay in the subsoil than the Knox soil. They are on side slopes below the Knox soil. Included soils make up about 10 percent of the unit.

Important properties of the Knox soil—

Permeability: Moderate
Surface runoff: Rapid
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are used as pasture or hayland. The main management concern is erosion. Most areas can be terraced and farmed on the contour. Installing either broad-base terraces or terraces that have steep back slopes along with suitable outlets helps to control erosion. Constructing grassed waterways helps to control erosion in drainageways and provides an outlet for terrace drains. Conservation tillage practices conserve moisture, maintain tilth, and minimize the damage caused by the impact of raindrops. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to trees. No major concerns affect timber management. Many areas are suited to year-round forestry activities, except during periods when the soil is saturated. Most conventional harvesting and planting methods can be used. Nutrient supplies and the water-holding capacity are good. Erosion is generally not a problem, except in areas where the slope is more than 15 percent.

This soil is suited to building site development and septic tank absorption fields. The construction of dwellings without basements is limited by the shrink-swell potential and the slope. Constructing footings, foundations, and basement walls with adequately reinforced concrete and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Dwellings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping. Land shaping and installing the distribution lines across the slope are necessary for the proper functioning of the absorption field.

Low strength, the shrink-swell potential, the slope, and the potential for frost action limit the use of this soil as a site for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action. Roads can be designed so that they conform to the natural contour of the land. Some cut and fill may be necessary.

The land capability classification is IIIe. The woodland ordination symbol is 4A.

42E2—Knox silt loam, 14 to 20 percent slopes, eroded. This very deep, moderately steep, well drained soil is on side slopes in the uplands. Much of the original surface soil has eroded away. The present surface layer has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to 250 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 5 inches, very dark grayish brown, friable silt loam

Subsoil:
5 to 12 inches, brown, friable silt loam
12 to 30 inches, dark yellowish brown, firm silty clay loam
30 to 52 inches, dark yellowish brown, mottled, firm silty clay loam

Substratum:
52 to 60 inches, dark yellowish brown, mottled, friable silt loam

In some places the surface layer is silty clay loam. In other places terrace construction has removed as much as 2 feet of soil material and has exposed the subsoil.

Included with this soil in mapping are areas of Napier, Timula, and Vanmeter soils. Napier soils are on foot slopes. They have a very thick, dark surface layer. Timula soils have less clay throughout than the Knox

soil. They are in the same landscape positions as the Knox soil. The moderately well drained Vanmeter soils are moderately deep over weathered bedrock and have more clay in the subsoil than the Knox soil. They are on the lower side slopes below the Knox soil. Included soils make up about 10 percent of the unit.

Important properties of the Knox soil—

Permeability: Moderate
Surface runoff: Rapid
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

Many areas of this soil have been cleared of trees and are used for cultivated crops, pasture, or hay. Some areas are used as woodland. This soil is suited to corn, soybeans, and small grain. The main management concern is erosion. Most areas can be terraced and farmed on the contour. Installing terraces that have steep back slopes along with suitable outlets helps to control erosion. Constructing grassed waterways helps to control erosion in drainageways and provides an outlet for terrace drains. Conservation tillage practices conserve moisture, maintain tilth, and minimize the damage caused by the impact of raindrops. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration. In the steeper areas, erosion is a serious concern even if terraces are installed and conservation tillage methods are used. Converting cropland to permanent vegetative cover, such as pasture, can help to prevent further erosion in these areas.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to trees. Equipment limitations and the erosion hazard are management concerns. The slope limits the use of equipment and increases the hazard of erosion. As the slope gradient increases, the use of wheeled equipment becomes more difficult. On the steeper slopes, track type equipment should be used. Constructing water bars and out-sloping road surfaces, adding culverts and drop structures, creating riparian buffer strips, seeding exposed areas, and locating haul roads and skid trails on the contour or on the gentler slopes help to prevent excessive soil loss.

This soil generally is not used for building site development or onsite waste disposal systems because of the slope. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the shrink-swell potential, the potential for frost action, and the slope are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action. Cut and fill generally are necessary to adjust the slopes to an acceptable grade.

The land capability classification is IVe. The woodland ordination symbol is 4R.

42F—Knox silt loam, 20 to 35 percent slopes. This very deep, moderately steep and steep, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from about 70 to 280 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 8 inches, very dark grayish brown, friable silt loam

Subsurface layer:
8 to 12 inches, brown, friable silt loam

Subsoil:
12 to 31 inches, dark yellowish brown, firm silty clay loam
31 to 45 inches, yellowish brown, mottled, friable silt loam

Substratum:
45 to 60 inches, yellowish brown, mottled, friable silt loam

Important soil properties—

Permeability: Moderate
Surface runoff: Very rapid
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

Included with this soil in mapping are areas of Napier and Vanmeter soils. Napier soils are on foot slopes. They have a very thick, dark surface layer. The moderately well drained Vanmeter soils are less than 40

inches deep to bedrock. They are on the lower side slopes below the Knox soil. Also included are areas of Knox soils on narrow ridgetops that have slopes of 5 to 9 percent. Included soils make up about 10 percent of the unit.

Most areas are wooded. The main species are white oak, northern red oak, black oak, shagbark hickory, and sugar maple. Commercial timber harvest is limited, however, and the wooded areas are used mainly for wildlife habitat or recreation. A few of the less sloping areas are used for pasture, hay, or crops.

Only the areas that have slopes of less than about 25 percent are suited to pasture renovation. This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Care is needed when pastures are reestablished because of the severe hazard of erosion. Pastures should be renovated only when necessary for maintaining production. Plants should be established in strips that follow the contour. Plowing and cultivation should be avoided. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to trees. Equipment limitations and the erosion hazard are management concerns. The slope limits the use of equipment and increases the hazard of erosion. As the slope gradient increases, the use of wheeled equipment becomes more difficult. On the steeper slopes, track type equipment should be used. In the steepest areas, even track type equipment cannot be used safely. In these areas it may be necessary to yard the logs uphill with cables. The number of suitable landing sites is very limited. Tree planting may be restricted to hand planting in areas where slopes are more than 35 percent. Constructing water bars and out-sloping road surfaces, adding culverts and drop structures, creating riparian buffer strips, seeding exposed areas, and building logging roads and skid trails on the contour or on the gentler slopes help to prevent excessive soil loss.

This soil generally is not used for building site development or onsite waste disposal systems because of the slope. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the shrink-swell potential, the potential for frost action, and the slope are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action. Cut and fill generally are necessary to adjust the slopes to an acceptable grade.

The land capability classification is VIe. The woodland ordination symbol is 4R.

44C2—Lamoni silty clay loam, 5 to 9 percent slopes, eroded. This very deep, moderately sloping, somewhat poorly drained soil is on side slopes in the uplands. Much of the original dark surface soil has eroded away. The present surface layer has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to 50 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 8 inches, black, firm silty clay loam

Subsoil:
8 to 13 inches, dark grayish brown, mottled, firm clay loam
13 to 48 inches, dark brown, grayish brown, and gray, mottled, firm clay loam

Substratum:
48 to 60 inches, gray and yellowish brown, mottled, firm clay loam

In places the dark surface layer is more than 10 inches thick.

Included with this soil in mapping are areas of Exira and Shelby soils. Also included are some severely eroded areas on shoulders. These areas have more clay in the surface layer than the Lamoni soil. The well drained Exira soils are on back slopes above the Lamoni soil. They formed in loess and have less clay throughout than the Lamoni soil. The moderately well drained Shelby soils are on the lower back slopes below the Lamoni soil. They have less clay and a higher content of coarse fragments throughout than the Lamoni soil. Included soils make up about 15 percent of the unit.

Important properties of the Lamoni soil—

Permeability: Moderately slow in the upper part, slow in the next part, very slow in the lower part
Surface runoff: Medium
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: High
Seasonal high water table: Perched at a depth of 1 to 3 feet

Most areas are used for cultivated crops. A few areas are used as pasture or hayland. This soil is suited to corn, soybeans, and small grain. The main

management concern is erosion. Most areas can be terraced and farmed on the contour. Installing broad-base terraces along with suitable outlets helps to control erosion. Terrace drains generally are needed because of the restricted permeability in the subsoil. Constructing grassed waterways helps to control erosion in drainageways and provides an outlet for terrace drains. If exposed by terracing, the clayey subsoil cannot be easily tilled, is low in fertility, and has a lower available water capacity. In some areas the exposed subsoil can be covered with topsoil stockpiled from areas under construction. Restricting fieldwork when the soil is wet minimizes soil compaction and cloddiness. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to grasses and legumes for pasture and hay. Species that are tolerant of wetness, such as alfalfa, red clover, reed canarygrass, smooth brome, tall fescue, eastern gamagrass, switchgrass, and indiangrass, are best suited to this soil. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to building site development and sewage lagoons. The wetness and the high shrink-swell potential are limitations on sites for dwellings. Constructing footings, foundations, and basement walls with adequately reinforced concrete and backfilling with sand or gravel minimize the damage caused by shrinking and swelling. Installing drainage tile around footings helps to prevent the damage caused by wetness. Properly constructed lagoons can function adequately if the site can be leveled. This soil is unsuited to conventional septic tank absorption fields because of the restricted permeability.

Low strength, the shrink-swell potential, the wetness, and the potential for frost action are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

46—Luton clay, rarely flooded. This very deep, nearly level, poorly drained soil is on high flood plains along the Missouri River. The soil is protected by levees but is subject to flooding if the levees are broken or overtopped. Individual areas are irregular in shape and range from about 30 to 2,000 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 7 inches, very dark gray, very firm clay

Subsurface layer:
7 to 38 inches, very dark gray, mottled, very firm silty clay and clay

Subsoil:
38 to 60 inches, dark gray, mottled, very firm silty clay

In some places the surface layer is silty clay loam. In other places the lower part of the soil has thin layers of silt loam and silty clay loam. In some areas loam or silt loam is below a depth of 40 inches.

Included with this soil in mapping are areas of Blencoe soils. Also included, on the river side of the levee, are small areas of Luton soils that are frequently flooded. The somewhat poorly drained Blencoe soils are in the slightly higher areas. They have loamy material below a depth of 25 inches. Included soils make up about 10 percent of the unit.

Important properties of the Luton soil—

Permeability: Very slow
Surface runoff: Very slow
Available water capacity: Moderate
Organic matter content: Moderate
Shrink-swell potential: High
Depth to the water table: 1 to 3 feet

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The main management concern is wetness. Open ditches and shallow surface drains help to remove excess water. Many areas have been effectively drained. In these areas, maintaining the present drainage system is needed for the efficient removal of excess water. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the spring. If this soil is tilled when wet, the seedbed becomes cloddy and cannot be easily managed. Tilling only when the soil is at the proper moisture content helps to minimize compaction and the formation of clods. Conservation tillage practices improve tilth in the surface layer. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to grasses and legumes for pasture. The main limitation is the wetness. Species that are tolerant of wetness, such as alsike clover, ladino clover, tall fescue, smooth brome, orchardgrass, and reed canarygrass are best suited to this soil. Warm-season grasses, such as eastern gamagrass, switchgrass, and big bluestem, are well suited. Controlling grazing in wet areas helps to minimize compaction and helps to maintain a good sod cover. The soil generally is not used for hay crops because of the wetness. Surface drains and field ditches help to remove excess surface water.

This soil generally is not used for building site development or onsite waste disposal systems because of the flooding, the wetness, the high shrink-swell potential, and the restricted permeability. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the shrink-swell potential, the wetness, the potential for frost action, and the flooding are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling, wetness, and frost action. Roads should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification is IIIw. No woodland ordination symbol is assigned.

50B—Marshall silty clay loam, 2 to 5 percent slopes. This very deep, gently sloping, well drained soil is on ridgetops in the uplands and on stream terraces in stream valleys. Individual areas are mostly long, narrow, and branching and range from about 5 to 1,850 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
- 0 to 9 inches, very dark brown, friable silty clay loam

Subsurface layer:
- 9 to 19 inches, very dark grayish brown, friable and firm silty clay loam

Subsoil:
- 19 to 40 inches, dark yellowish brown, firm silty clay loam
- 40 to 60 inches, dark yellowish brown, mottled, firm silty clay loam

In some places the dark upper layers are less than 10 inches thick. In other places the surface layer is silt loam.

Important soil properties—

Permeability: Moderate
Surface runoff: Medium
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are used as pasture or hayland. This soil is suited to corn, soybeans, and small grain. The main management concern is the hazard of erosion. Most areas are too narrow to be managed separately but can be terraced and farmed on the contour along with adjacent areas of more sloping soils. The hazard of erosion can be reduced by using a conservation tillage system that leaves a protective cover of crop residue on the surface, planting cover crops, and farming on the contour. Returning crop residue or other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to building site development and septic tank absorption fields. The construction of dwellings is limited by the shrink-swell potential. Constructing footings, foundations, and basement walls with adequately reinforced concrete and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Septic tank absorption fields function adequately if proper design and installation procedures are used. Longer distribution lines are needed because of the restricted permeability.

Low strength, the shrink-swell potential, and the potential for frost action are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to minimize the damage caused by shrinking and swelling and by frost action.

The land capability classification is IIe. No woodland ordination symbol is assigned.

50C2—Marshall silty clay loam, 5 to 9 percent slopes, eroded. This very deep, moderately sloping, well drained soil is on ridgetops in the uplands. Much of the original dark surface soil has eroded away. The present surface layer has been mixed with the upper part of the subsoil. Individual areas are mostly long, narrow, and branching and range from about 5 to 1,100 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 7 inches, very dark brown, friable silty clay loam

Subsoil:
7 to 14 inches, dark yellowish brown, firm silty clay loam
14 to 55 inches, dark yellowish brown and yellowish brown, mottled, firm silty clay loam

Substratum:
55 to 60 inches, yellowish brown, mottled, friable silt loam

In some places, the dark upper layers are more than 10 inches thick and slopes are less than 5 percent. In other places the surface layer is silt loam.

Included with this soil in mapping are small areas of Contrary and Shelby soils. These soils are on secondary ridgetops and in saddles. Contrary soils have grayish mottles in the upper part of the subsoil. The moderately well drained Shelby soils contain glacial sand and gravel. Included soils make up about 5 percent of the unit.

Important properties of the Marshall soil—

Permeability: Moderate
Surface runoff: Medium
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are used as pasture or hayland. This soil is suited to corn, soybeans, and small grain. The main management concern is the hazard of erosion. Most areas are too narrow to be managed separately, but they can be terraced and farmed on the contour along with adjacent areas of more sloping soils. The hazard of erosion can be reduced by using a conservation tillage system that leaves a protective cover of crop residue on the surface, planting cover crops, and farming on the contour. Returning crop residue to the soil and adding other organic material improve fertility, minimize crusting, and increase the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to building site development and septic tank absorption fields. The construction of dwellings is limited by the shrink-swell potential. Constructing footings, foundations, and basement walls with adequately reinforced concrete and backfilling with sand or gravel minimize the damage caused by shrinking and swelling. Septic tank absorption fields function adequately if proper design and installation procedures are used. Longer distribution lines are needed because of the restricted permeability.

Low strength, the shrink-swell potential, and the potential for frost action are limitations on sites for local roads and streets. Adding crushed rock or other suitable material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

50D2—Marshall silty clay loam, 9 to 14 percent slopes, eroded. This very deep, strongly sloping, well drained soil is on side slopes in the uplands. Much of the original dark surface soil has eroded away. The present surface layer has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to 650 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 7 inches, very dark grayish brown, firm silty clay loam

Subsoil:
7 to 16 inches, dark yellowish brown, firm silty clay loam
16 to 36 inches, dark yellowish brown and yellowish brown, mottled, firm silty clay loam

Substratum:

36 to 60 inches, yellowish brown, mottled, friable silt loam

In some places the dark upper layers are more than 10 inches thick. In other places terrace construction has removed as much as 2 feet of soil material and has exposed the subsoil.

Included with this soil in mapping are areas of Judson, Lamoni, and Shelby soils. Judson soils are on foot slopes. They have a very thick, dark surface layer. The somewhat poorly drained Lamoni and moderately well drained Shelby soils are on side slopes below the Marshall soil. Lamoni soils have more clay in the subsoil than the Marshall soil, and Shelby soils contain glacial sand and gravel. Included soils make up about 10 percent of the unit.

Important properties of the Marshall soil—

Permeability: Moderate
Surface runoff: Rapid
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are used for pasture and hay. This soil is suited to corn, soybeans, and small grain. The main management concern is the hazard of erosion. Most areas can be terraced and farmed on the contour. Installing either broad-base terraces or terraces that have steep back slopes along with suitable outlets helps to control erosion. Constructing grassed waterways helps to control erosion in drainageways and provides an outlet for terrace drains. Conservation tillage practices conserve moisture, maintain tilth, and minimize the damage caused by the impact of raindrops. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to building site development and septic tank absorption fields. The construction of dwellings without basements is limited by the shrink-swell potential and the slope. Constructing footings, foundations, and basement walls with adequately reinforced concrete and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Dwellings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping. Land shaping and installing longer distribution lines across the slope are necessary for the proper functioning of the septic tank absorption field.

Low strength, the shrink-swell potential, the potential for frost action, and the slope are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action. Roads can be designed so that they conform to the natural contour of the land. Some cut and fill may be necessary.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

52—Motark silt loam, rarely flooded. This very deep, nearly level, moderately well drained soil is on high flood plains along the Missouri River. The soil is protected by levees but is subject to flooding if the levees are broken or overtopped. Individual areas are irregular in shape and range from about 10 to 350 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:

0 to 9 inches, very dark grayish brown, very friable silt loam

Substratum:

9 to 15 inches, layers of dark grayish brown and brown, mottled, very friable silt loam

15 to 60 inches, layers of dark grayish brown, grayish brown, and brown, mottled, very friable silt loam

Included with this soil in mapping are areas of Dupo, Luton, and Napier soils. The somewhat poorly drained Dupo soils are in the slightly lower areas. They are clayey in the lower part. The poorly drained Luton soils are in the lower areas. They are clayey throughout. The well drained Napier soils are on foot slopes adjacent to the uplands. They have a very thick, dark surface layer. Included soils make up about 10 percent of the unit.

Important properties of the Motark soil—

Permeability: Moderate
Surface runoff: Very slow
Available water capacity: Very high
Organic matter content: Moderately low
Shrink-swell potential: Low
Depth to the water table: 2.5 to 4.0 feet

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. It has few limitations. Conservation tillage practices conserve moisture and help to maintain tilth. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as ladino clover, red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and switchgrass. No major limitations affect pasture and hayland.

This soil is suited to trees. No major concerns affect timber management.

This soil generally is not used for building site development or onsite waste disposal systems because of the flooding and the wetness. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the potential for frost action, and the flooding are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by frost action. Roads should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification is I. The woodland ordination symbol is 9A.

54B—Monona silt loam, 2 to 5 percent slopes. This very deep, gently sloping, well drained soil is on ridgetops in the uplands. Individual areas are mostly long, narrow, and branching and range from about 10 to 1,000 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 6 inches, black, friable silt loam

Subsurface layer:
6 to 21 inches, very dark grayish brown and dark brown, friable silt loam

Subsoil:
21 to 46 inches, dark yellowish brown, mottled, friable silt loam

Substratum:
46 to 60 inches, yellowish brown, mottled, friable silt loam

In places the dark surface layer is less than 10 inches thick.

Important soil properties—

Permeability: Moderate
Surface runoff: Medium
Available water capacity: Very high
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are used as pasture or hayland. This soil is suited to corn, soybeans, and small grain. The main management concern is the hazard of erosion. Some areas are too narrow to be managed separately, but they can be terraced and farmed on the contour along with adjacent areas of more sloping soils. The hazard of erosion can be reduced by using a conservation tillage system that leaves a protective cover of crop residue on the surface, planting cover crops, and farming on the contour. Returning crop residue or other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to building site development and septic tank absorption fields. The construction of dwellings is limited by the shrink-swell potential. Constructing footings, foundations, and basement walls with adequately reinforced concrete and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Septic tank absorption fields function adequately if proper design and installation procedures are used. Longer distribution lines are needed because of the restricted permeability.

Low strength, the shrink-swell potential, and the potential for frost action are limitations on sites for local roads and streets. Adding crushed rock or other suitable material minimizes the damage caused by low strength. Grading the roads so that they shed water,

constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action.

The land capability classification is IIe. No woodland ordination symbol is assigned.

54C2—Monona silt loam, 5 to 9 percent slopes, eroded. This very deep, moderately sloping, well drained soil is on ridgetops in the uplands. Much of the original dark surface soil has eroded away. The present surface layer has been mixed with the upper part of the subsoil. Individual areas are long, narrow, and branching and range from about 5 to 900 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 9 inches, dark brown, friable silt loam

Subsoil:
9 to 15 inches, brown, friable silt loam
15 to 28 inches, yellowish brown, friable silt loam

Substratum:
28 to 60 inches, yellowish brown, mottled, friable silt loam

In places, the dark surface layer is more than 10 inches thick and slopes are less than 5 percent.

Included with this soil in mapping are small areas of Contrary soils on secondary ridges, in saddles, and on shoulders. These soils have a thinner surface layer than the Monona soil and have gray mottles in the upper part of the subsoil. They make up about 5 percent of the unit.

Important properties of the Monona soil—

Permeability: Moderate
Surface runoff: Medium
Available water capacity: Very high
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are used as pasture or hayland. This soil is suited to corn, soybeans, and small grain. The main management concern is the hazard of erosion. Most areas are too narrow to be managed separately, but they can be terraced and farmed on the contour along with adjacent areas of more sloping soils. The hazard of erosion can be reduced by using a conservation tillage system that leaves a protective cover of crop residue on the surface, planting cover crops, and farming on the contour. Returning crop residue to the soil or adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to building site development and septic tank absorption fields. The construction of dwellings is limited by the shrink-swell potential. Constructing footings, foundations, and basement walls with adequately reinforced concrete and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Septic tank absorption fields function adequately if proper design and installation procedures are used. Longer distribution lines are necessary because of the restricted permeability.

Low strength, the shrink-swell potential, and the potential for frost action are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

54D2—Monona silt loam, 9 to 14 percent slopes, eroded. This very deep, strongly sloping, well drained soil is on side slopes in the uplands. Much of the original surface soil has eroded away. The present surface layer has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 5 to 300 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 8 inches, very dark brown, friable silt loam

Subsoil:
8 to 20 inches, dark yellowish brown, friable silt loam
20 to 40 inches, dark yellowish brown, mottled, friable silt loam

Substratum:
40 to 60 inches, yellowish brown, mottled, friable silt loam

In some places the dark surface layer is more than 10 inches thick. In other places terrace construction has removed as much as 2 feet of soil material and has exposed the substratum.

Included with this soil in mapping are areas of Napier, Shelby, and Timula soils. Napier soils are on foot slopes. They have a very thick, dark surface layer. The moderately well drained Shelby soils are on nose slopes and the lower back slopes below the Monona soil. They contain glacial sand and gravel and have more clay throughout than the Monona soil. Timula soils are calcareous just below the surface layer and have less clay in the subsoil than the Monona soil. Included soils make up about 10 percent of the unit.

Important properties of the Monona soil—

Permeability: Moderate
Surface runoff: Rapid
Available water capacity: Very high
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are used for pasture and hay. This soil is suited to corn, soybeans, and small grain. The main management concern is the hazard of erosion. Most areas can be terraced and farmed on the contour. Installing either broad-base terraces or terraces that have steep back slopes along with suitable outlets helps to control erosion. Constructing grassed waterways helps to control erosion in drainageways and provides an outlet for terrace drains. Conservation tillage practices conserve moisture, maintain tilth, and minimize the damage caused by the impact of raindrops. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to building site development and septic tank absorption fields. The construction of dwellings without basements is limited by the slope and the shrink-swell potential. Dwellings should be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping. Constructing footings, foundations, and basement walls with adequately reinforced concrete and backfilling with sand or gravel help to minimize the damage caused by shrinking and swelling. Land shaping and installing the distribution lines across the slope are necessary for the proper functioning of septic tank absorption fields.

Low strength, the shrink-swell potential, the potential for frost action, and the slope are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action. Roads can be designed so that they conform to the natural slope of the land. Some cut and fill may be necessary because of the slope.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

56—Dupo silt loam, rarely flooded. This very deep, nearly level, somewhat poorly drained soil is on high flood plains along the Missouri River. The soil is protected by levees but is subject to flooding if the levees are broken or overtopped. Individual areas are irregular in shape and range from about 15 to 500 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 8 inches, very dark grayish brown, friable silt loam

Substratum:
8 to 31 inches, stratified black, very dark grayish brown, and dark grayish brown, mottled, friable silt loam
31 to 60 inches, black, very firm clay

In some places the depth to the clayey layer is less than 20 inches. In other places the upper part of the profile is silty clay loam.

Included with this soil in mapping are areas of Dockery, Motark, and Wabash soils. Dockery soils are silt loam or silty clay loam to a depth of 50 inches or more. They are in the slightly lower areas. The moderately well drained Motark soils are in the higher areas. They are silt loam to a depth of 60 inches or more. The poorly drained Wabash soils are in depressions. They are clayey to a depth of 60 inches or

more. Included soils make up about 5 to 10 percent of the unit.

Important properties of the Dupo soil—

Permeability: Moderate in the upper part, slow in the lower part
Surface runoff: Very slow
Available water capacity: High
Organic matter content: Moderately low
Shrink-swell potential: Low in the upper part, high in the lower part
Depth to the water table: 1.5 to 3.5 feet

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The main management concern is wetness. Open ditches and shallow surface drains help to remove excess water. Some areas have been drained. In these areas, maintaining the present drainage system is needed for the efficient removal of excess water. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the spring. Tilling only when the soil is at the proper moisture content helps to minimize compaction and the formation of clods. Returning crop residue and other organic material to the soil improves tilth, fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to grasses and legumes for pasture and hay. The main limitation is the wetness. Ladino clover, red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and switchgrass are best suited to this soil. Surface drains and field ditches help to remove excess surface water. Controlling grazing in wet areas helps to minimize compaction and helps to maintain a good sod cover.

This soil generally is not used for building site development or onsite waste disposal systems because of the flooding, the wetness, the restricted permeability, and the shrink-swell potential. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the potential for frost action, and the flooding are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by frost action. Roads should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification is IIw. No woodland ordination symbol is assigned.

57—Modale silt loam, rarely flooded. This very deep, nearly level, somewhat poorly drained soil is on low flood plains along the Missouri River. The soil is protected by levees but is subject to flooding if the levees are broken or overtopped. Individual areas are irregular in shape and range from about 75 to 500 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 9 inches, very dark grayish brown, friable silt loam

Substratum:
9 to 30 inches, stratified brown and dark grayish brown, mottled, friable silt loam
30 to 60 inches, dark grayish brown, mottled, firm silty clay

In some places the depth to the clayey layer is less than 18 inches. In other places the upper part of the profile is silty clay loam.

Included with this soil in mapping are areas of Haynie and Luton soils. The well drained Haynie soils are in the higher areas. They are silt loam to a depth of 60 inches or more. The poorly drained Luton soils are in the lower areas. They are clayey throughout. Included soils make up about 10 percent of the unit.

Important properties of the Modale soil—

Permeability: Moderate in the upper part, slow in the lower part
Surface runoff: Very slow
Available water capacity: High
Organic matter content: Moderately low
Shrink-swell potential: Low in the upper part, high in the lower part
Depth to the water table: 1.5 to 3.0 feet

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The main management concern is wetness. Open ditches and shallow surface drains help to remove excess water. Some areas have been drained. In these areas, maintaining the present drainage system is needed for the efficient removal of excess water. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the spring. Tilling only when the soil is at the proper moisture content helps to minimize compaction and the formation of clods. Returning crop residue and other organic material to the soil improves tilth and fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to grasses and legumes for pasture and hay. The main limitation is the wetness. Ladino clover, red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and

switchgrass are best suited to this soil. Surface drains and field ditches help to remove excess surface water. Controlling grazing in wet areas helps to minimize compaction and helps to maintain a good sod cover.

This soil generally is not used for building site development or onsite waste disposal systems because of the flooding, the wetness, the restricted permeability, and the shrink-swell potential. Levee failure and flooding are also possible. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the potential for frost action, and the flooding are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by frost action. Roads should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification is IIw. No woodland ordination symbol is assigned.

58B—Motark-Napier silt loams, 1 to 7 percent slopes. This map unit consists of very deep, very gently sloping and moderately sloping soils on narrow flood plains and foot slopes. The moderately well drained Motark soil is on flood plains and is subject to occasional flooding. The well drained Napier soil is on foot slopes adjacent to the flood plain. The proportions of the soils in the unit are variable but range from about 35 to 55 percent for each soil. The Motark soil is dominant in the larger drainageways, and the Napier soil is dominant in the smaller drainageways. Individual areas of this map unit are long, narrow, and branching and range from about 30 to 1,230 acres in size. The soils are in narrow bands and could not be mapped separately at the scale used.

The typical sequence, depth, and composition of the layers of the Motark soil are as follows—

Surface layer:
0 to 8 inches, dark brown, very friable silt loam

Substratum:
8 to 42 inches, brown, dark brown, and black, very friable silt loam
42 to 60 inches, very dark grayish brown and very dark brown, very friable silt loam with red iron stains

In some areas the subsoil is grayer.

Important properties of the Motark soil—

Permeability: Moderate
Surface runoff: Very slow
Available water capacity: Very high
Organic matter content: Moderately low
Shrink-swell potential: Low
Depth to the water table: 3 to 5 feet

The typical sequence, depth, and composition of the layers of the Napier soil are as follows—

Surface layer:
0 to 10 inches, dark brown, friable silt loam

Subsurface layer:
10 to 24 inches, very dark brown, firm silt loam

Subsoil:
24 to 60 inches, dark yellowish brown, firm silt loam

Important properties of the Napier soil—

Permeability: Moderate
Surface runoff: Medium
Available water capacity: Very high
Organic matter content: Moderate
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

In some areas the subsoil is grayer.

Included with the Motark and Napier soils in mapping are steep to nearly vertical streambanks and gullies 5 to 30 feet deep. Included areas make up about 10 percent of the unit.

Most areas are used for cultivated crops, pasture, or hay. A narrow strip on both sides of most drainageways is overgrown with trees and brush and is used as wildlife habitat. These soils are suited to corn, soybeans, and small grain. The major management concerns are occasional flooding and streambank erosion on the Motark soil and erosion on the Napier soil. Because of the steep streambanks, many areas cannot be crossed with farm equipment. Flooding can delay planting and harvesting and may reduce crop yields in some years. Maintaining a filter strip of permanent vegetation along the edges of the stream channel helps to protect the stream from sedimentation and helps to stabilize streambanks. Erosion on the Napier soil can be controlled by using a conservation tillage system that leaves a protective cover of crop residue on the surface, planting winter cover crops, and farming on the contour. Diversions may be needed in some areas to protect these soils from runoff from upland areas. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

These soils are suited to most commonly grown grasses and legumes, such as red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and switchgrass. The main

limitations are flooding on the Motark soil and erosion on the Napier soil during seedbed preparation. Controlling grazing during periods of flooding helps to minimize compaction and helps to maintain a good sod cover. Sedimentation during flooding can reduce forage yields and may kill plants in some areas. Erosion can be minimized by preparing the seedbed on the contour and by timing tillage so that a good ground cover is quickly established.

The Motark soil is suited to trees. No major concerns affect timber management.

The Motark soil is generally not used for building site development or onsite waste disposal systems because of the occasional flooding. Dwellings and septic tank absorption fields should be located in areas of the more favorable Napier soil. No major problems affect dwellings and septic tank absorption fields on the Napier soil.

Low strength, the potential for frost action, and the flooding are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to minimize the damage caused by frost action. Roads should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification of the Motark soil is IIw, and that of the Napier soil is IIe. The woodland ordination symbol for the Motark soil is 9A. No woodland ordination symbol is assigned for the Napier soil.

59B—Nodaway-Judson silt loams, 1 to 7 percent slopes. This map unit consists of very deep soils on narrow flood plains and foot slopes. The very gently sloping, moderately well drained Nodaway soil is on flood plains and is subject to occasional flooding. The gently sloping and moderately sloping, well drained Judson soil is on foot slopes adjacent to the uplands. The proportions of the soils in the unit are variable but range from about 35 to 55 percent for each soil. The Nodaway soil is dominant on the larger flood plains, and the Judson soil is dominant on the smaller flood plains. Individual areas of these soils are long, narrow, and branching and range from about 35 to 1,200 acres in size. The soils are in narrow bands and could not be mapped separately at the scale used.

The typical sequence, depth, and composition of the layers of the Nodaway soil are as follows—

Surface layer:
0 to 8 inches, very dark grayish brown, friable silt loam

Substratum:
8 to 53 inches, stratified dark grayish brown and black, mottled, friable silt loam and silty clay loam
53 to 60 inches, very dark brown and dark brown, mottled, friable silty clay loam

Important properties of the Nodaway soil—

Permeability: Moderate
Surface runoff: Slow
Available water capacity: Very high
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: 3 to 5 feet

The typical sequence, depth, and composition of the layers of the Judson soil are as follows—

Surface layer:
0 to 7 inches, very dark grayish brown, friable silt loam

Subsurface layer:
7 to 20 inches, very dark grayish brown, firm silty clay loam

Subsoil:
20 to 45 inches, brown and dark yellowish brown, firm silty clay loam

Substratum:
45 to 60 inches, yellowish brown, mottled, firm silty clay loam

In some areas on the flood plain, the subsoil is grayer.

Important properties of the Judson soil—

Permeability: Moderate
Surface runoff: Medium
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

Included with the Nodaway and Judson soils in mapping are steep to nearly vertical streambanks and gullies 5 to 30 feet deep. These areas make up less than 10 percent of the unit. Also included are somewhat poorly drained soils in the slightly lower areas farther from the stream channels than the major soils. Included soils make up about 10 percent of the unit.

Most areas are used for cultivated crops, pasture, or hay. A narrow strip on both sides of most drainageways is overgrown with trees and brush and is used as wildlife habitat. These soils are suited to corn, soybeans, and small grain. The major management concerns are the occasional flooding and streambank erosion on the Nodaway soil and erosion on the Judson

soil. Because of the steep streambanks, many areas cannot be crossed with farm equipment. Flooding can delay planting and harvesting and may reduce crop yields in some years. Maintaining a filter strip of permanent vegetation along the edges of the stream channel helps to protect the stream from sedimentation and helps to stabilize streambanks. Erosion on the Judson soil can be controlled by using a conservation tillage system that leaves a protective cover of crop residue on the surface, planting winter cover crops, and farming on the contour. Diversions may be needed in some places to protect these soils from upland runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

These soils are suited to most commonly grown grasses and legumes, such as ladino clover, red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and switchgrass. The main limitations are the flooding on the Nodaway soil and the hazard of erosion on the Judson soil during seedbed preparation. Controlling grazing during periods of flooding helps to minimize compaction and helps to maintain a good sod cover. Sedimentation during flooding reduces forage yields and may kill plants in some areas. Erosion can be minimized by preparing the seedbed on the contour and by timing tillage so that a good ground cover is quickly established.

The Nodaway soil is suited to trees. No major concerns affect timber management. Many areas are suited to year-round forestry activities, except during periods when the soil is saturated. Most conventional harvesting and planting methods can be used. The nutrient supply and available water capacity are good.

The Nodaway soil generally is not used for building site development or onsite waste disposal systems because of the occasional flooding. Dwellings and septic tank absorption fields should be located in areas of the more favorable Judson soil. No major problems affect dwellings and septic tank absorption fields on the Judson soil.

Low strength, the shrink-swell potential, the potential for frost action, and the flooding are limitations if these soils are used as sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action. Roads should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification of the Nodaway soil is IIw, and that of the Judson soil is IIe. The woodland ordination symbol for the Nodaway soil is 3A. No woodland ordination symbol is assigned for the Judson soil.

60—Nodaway silt loam, occasionally flooded. This very deep, nearly level, moderately well drained soil is on narrow flood plains. Some areas are protected by levees. Individual areas are mostly long and narrow and range from about 10 to 1,600 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 7 inches, very dark grayish brown, friable silt loam

Substratum:
7 to 43 inches, stratified very dark grayish brown and dark brown, mottled, friable silty clay loam and silt loam
43 to 60 inches, layers of black and very dark brown, mottled, firm silty clay loam

In places the surface layer is silty clay loam.

Included with this soil in mapping are areas of Colo, Judson, and Motark soils. The poorly drained Colo and well drained Judson soils have a very thick, dark surface layer. Colo soils are in the lower areas farther from the channel than the Nodaway soil. Judson soils are on foot slopes. The moderately well drained Motark soils have less clay in the substratum than the Nodaway soil. They are in the slightly higher areas. Included soils make up about 10 percent of the unit.

Important properties of the Nodaway soil—

Permeability: Moderate
Surface runoff: Very slow
Available water capacity: Very high
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: 3 to 5 feet

Most areas are used for cultivated crops. A few areas are used for pasture and hay. This soil is suited to corn, soybeans, and small grain. The main management concern is the occasional flooding. Flooding can delay planting and harvesting and may reduce crop yields in some years. Diversions may be needed in some areas to protect this soil from upland runoff. Using a system of conservation tillage, planting cover crops, and returning crop residue to the surface layer increase fertility, improve tilth, and increase the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as ladino clover, red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and switchgrass. The main

limitation is the flooding. Controlling grazing during periods of flooding helps to minimize compaction and helps to maintain a good sod cover. Sedimentation during flooding reduces forage yields and may kill plants in some areas.

This soil is suited to trees. No major concerns affect timber management. Many areas are suited to year-round forestry activities, except during periods when the soil is saturated. Most conventional harvesting and planting methods can be used. The nutrient supply and available water capacity are good.

This soil generally is unsuited to building site development and onsite waste disposal systems because of the flooding and the wetness.

The land capability classification is IIw. The woodland ordination symbol is 3A.

61B—Napier silt loam, 1 to 7 percent slopes. This very deep, very gently sloping and moderately sloping, well drained soil is on foot slopes and some alluvial fans. Individual areas are mostly long and narrow and range from about 5 to 450 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 8 inches, very dark brown, friable silt loam

Subsurface layer:
8 to 31 inches, very dark brown, friable silt loam

Subsoil:
31 to 60 inches, brown, friable silt loam

Included with this soil in mapping are small areas of the somewhat poorly drained Dockery and moderately well drained Motark soils. These soils have a thin surface layer and are stratified below the surface layer. They are in the lower areas adjacent to stream channels. Included soils make up about 10 percent of the unit.

Important properties of the Napier soil—

Permeability: Moderate
Surface runoff: Medium
Available water capacity: Very high
Organic matter content: Moderate
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are used for pasture and hay. This soil is suited to corn, soybeans, and small grain. The main management concern is erosion in the steeper areas. Diversions may be needed in some areas to protect this soil from upland runoff. The hazard of erosion can be reduced by using a conservation tillage system that leaves a protective cover of crop residue on the surface, planting winter cover crops, and farming on the contour. Returning crop residue to the soil or regularly adding other organic material improves tilth and fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established.

This soil is suited to building site development and septic tank absorption fields. Limitations affecting these uses are slight.

Low strength and the potential for frost action are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by frost action.

The land capability classification is IIe. No woodland ordination symbol is assigned.

62B—Napier-Gullied land complex, 1 to 7 percent slopes. This very gently sloping to moderately sloping map unit is in small upland drainageways. The very deep, well drained Napier soil is on foot slopes dissected by steep to nearly vertical gullies that are 5 to 30 feet deep. The proportions of the components in this unit are variable but range from about 60 to 75 percent for the Napier soil and 15 to 35 percent for Gullied land. Individual areas are long, narrow, and branching and range from about 35 to 1,800 acres in size. The components are in narrow bands and could not be mapped separately at the scale used.

The typical sequence, depth, and composition of the layers of the Napier soil are as follows—

Surface layer:
0 to 8 inches, very dark grayish brown, friable silt loam

Subsurface layer:
8 to 24 inches, very dark grayish brown, friable silt loam

Subsoil:
24 to 60 inches, dark brown, friable silt loam

Important properties of the Napier soil—

Permeability: Moderate
Surface runoff: Medium
Available water capacity: Very high

Organic matter content: Moderate
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

Gullied land consists of steep to vertical streambanks and branching gully walls. Gullies are about 5 to more than 30 feet deep. They are commonly overgrown with trees and brush.

Included in mapping are small areas of the moderately well drained Motark soils. These soils have a thin, dark surface layer. They are adjacent to the stream channels. They make up about 10 percent of the unit.

This unit is used for cultivated crops or as wildlife habitat. A few areas are used for pasture and hay. Areas of the Napier soil along either side of the gully can be cultivated or used for pasture if the adjacent side slopes are cultivated or grazed. The Napier soil is suited to corn, soybeans, and small grain. The main management concerns are the hazard of erosion in the steeper areas and the hazard of further gully erosion. Diversions may be needed in some areas to protect this unit from upland runoff. The hazard of erosion can be reduced by using a conservation tillage system that leaves a protective cover of crop residue on the surface, planting winter cover crops, and farming on the contour. Returning crop residue to the soil or regularly adding other organic material improves tilth and fertility, minimizes crusting, and increases the rate of water infiltration. Maintaining a filter strip of permanent vegetation along the edges of the gullies helps to protect the stream from sedimentation and helps to stabilize the gullies.

The Napier soil is suited to most commonly grown grasses and legumes, such as alfalfa, red clover, reed canarygrass, tall fescue, smooth brome, eastern gamagrass, big bluestem, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established.

The Napier soil is suited to building site development and septic tank absorption fields. Limitations affecting these uses are slight. If septic tank absorption fields are located too close to the gullies, the contamination of streams is a hazard.

Low strength and the potential for frost action are limitations if the Napier soil is used as a site for local roads and streets. The roads and streets should be located as far away from the gullied areas as possible. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by frost action.

The land capability classification of the Napier soil is IIe, and that of the Gullied land is VIII. No woodland ordination symbol is assigned.

63—Leta silt loam, sandy substratum, rarely flooded. This very deep, nearly level, somewhat poorly drained soil is on low flood plains along the Missouri River. The soil is protected by levees but is subject to flooding if the levees are broken or overtopped. Individual areas are irregular in shape and range from about 25 to 550 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 10 inches, very dark brown, friable silt loam

Subsurface layer:
10 to 31 inches, very dark brown, firm silty clay

Substratum:
31 to 55 inches, stratified dark grayish brown and very dark grayish brown, mottled, friable silt loam and loam
55 to 60 inches, dark brown, loose sand

In some places the surface layer is silty clay loam. In other places where windblown sand has been mixed with the surface layer, the surface layer is fine sandy loam or loam. In a few areas the depth to the loamy horizon is less than 20 inches.

Included with this soil in mapping are small areas of Grable and Sarpy soils. The somewhat excessively drained Grable soils are in the higher areas. They have silt loam and very fine sandy loam in the upper part. The excessively drained Sarpy soils are on the higher narrow convex bars. They are sandy throughout. Included soils make up about 15 percent of the unit.

Important properties of the Leta soil—

Permeability: Slow in the upper part, moderate in the next part, rapid in the lower part
Surface runoff: Very slow
Available water capacity: Moderate
Organic matter content: Moderate
Shrink-swell potential: Moderate in the upper part, high in the next part, low in the lower part
Depth to the water table: 1 to 3 feet

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The main management concern is wetness. Open ditches and shallow surface drains help to remove excess water. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the

spring. The silt loam surface layer allows quick access to the fields during planting and harvesting. Returning crop residue and other organic material to the soil improves tilth and fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to grasses and legumes for pasture. The main limitation is the wetness. Species that are tolerant of wetness, such as alsike clover, ladino clover, tall fescue, smooth brome, orchardgrass, and reed canarygrass, are best suited to this soil. Warm-season grasses, such as eastern gamagrass, switchgrass, and big bluestem, are well suited. Controlling grazing in wet areas helps to minimize compaction and helps to maintain a good sod cover. The soil generally is not used for hay crops because of the wetness. Surface drains and field ditches help to remove excess surface water.

This soil is suited to trees. Equipment limitations and seedling mortality are management concerns. Clayey soils have inadequate traction, low strength, and a moderate seedling mortality rate and can easily become compacted when wet. Ruts form easily on unsurfaced roads and skid trails, and the roads may be impassable during rainy periods. Logging activities should be restricted to dry periods or surfaced areas. Seedling survival can be increased by using mechanical or chemical weed-control methods, providing shade, mulching, or providing supplemental water. Planting containerized stock that has well developed root systems or reinforcement planting can improve the seedling survival rate.

This soil generally is not used for building site development or onsite waste disposal systems because of the flooding, the wetness, and the restricted permeability. Levee failure and flooding are also possible. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the shrink-swell potential, the potential for frost action, and the flooding are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action. Roads should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification is IIw. The woodland ordination symbol is 7C.

64—Leta silty clay, rarely flooded. This very deep, nearly level, somewhat poorly drained soil is on low flood plains along the Missouri River. The soil is protected by levees but is subject to flooding if the levees are broken or overtopped. Individual areas are irregular in shape and range from about 25 to 1,200 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 8 inches, very dark grayish brown, firm silty clay

Subsurface layer:
8 to 19 inches, very dark grayish brown, mottled, firm silty clay

Subsoil:
19 to 28 inches, dark grayish brown, mottled, very firm silty clay

Substratum:
28 to 60 inches, stratified dark grayish brown and black, mottled, very friable silt loam and very fine sandy loam

In places the surface layer is silty clay loam. In a few areas the depth to the loamy horizon is less than 20 inches.

Included with this soil in mapping are small areas of Grable, Haynie, and Sarpy soils. The somewhat excessively drained Grable soils are in the higher areas. They are silt loam and very fine sandy loam in the upper part and sandy in the lower part. The well drained Haynie soils are in the higher areas. They are silt loam and very fine sandy loam throughout. The excessively drained Sarpy soils are on narrow convex bars. They are sandy throughout. Also included are poorly drained soils in the lower areas in old stream channels that are subject to ponding. The soils in these areas are variable and are stratified with textures ranging from sand to clay. Included soils make up about 15 percent of the unit.

Important properties of the Leta soil—

Permeability: Slow in the upper part, moderate in the lower part
Surface runoff: Very slow
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: High in the upper part, low in the lower part
Depth to the water table: 1 to 3 feet

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The main management concern is wetness. Open ditches and shallow surface drains help to remove excess water. Some areas have been drained. In these areas, maintaining the present drainage system is needed for

the efficient removal of excess water. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the spring. If this soil is tilled when wet, the seedbed becomes cloddy and cannot be easily managed. Tilling only when the soil is at the proper moisture content helps to minimize compaction and the formation of clods. Conservation tillage practices improve tilth in the surface layer. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to grasses and legumes for pasture. The main limitation is the wetness. Species that are tolerant of wetness, such as alsike clover, ladino clover, tall fescue, smooth brome, orchardgrass, and reed canarygrass, are best suited to this soil. Warm-season grasses, such as eastern gamagrass, switchgrass, and big bluestem, are well suited. Controlling grazing in wet areas helps to minimize compaction and helps to maintain a good sod cover. The soil generally is not used for hay crops because of the wetness. Surface drains and field ditches help to remove excess surface water.

This soil is suited to trees. Equipment limitations and seedling mortality are management concerns. Clayey soils have inadequate traction, low strength, and a moderate seedling mortality rate and can easily become compacted when wet. Ruts form easily on haul roads and skid trails, and the roads may be impassable during rainy periods. Harvesting and planting activities should be restricted to dry periods. Seedling survival can be improved by using mechanical or chemical weed-control methods, providing shade, mulching, or providing supplemental water. Planting containerized stock that has well developed root systems or reinforcement planting can increase the seedling survival rate.

This soil generally is not used for building site development or onsite waste disposal systems because of the flooding, the wetness, and the restricted permeability. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the shrink-swell potential, the potential for frost action, and the flooding are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action. Roads should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification is IIw. The woodland ordination symbol is 7C.

65—Leta silty clay, frequently flooded. This very deep, nearly level, somewhat poorly drained soil is on low flood plains along the Missouri River between the levees and the river channel. Individual areas are irregular in shape and range from about 20 to 450 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 8 inches, very dark brown, firm silty clay

Subsurface layer:
8 to 20 inches, very dark grayish brown, firm silty clay loam
20 to 24 inches, dark grayish brown, firm silty clay loam

Substratum:
24 to 32 inches, layers of dark grayish brown and brown, mottled, very friable silt loam
32 to 60 inches, brown, mottled, very friable very fine sandy loam

In some places the surface layer is silty clay loam. In other places the depth to the loamy horizon is less than 20 inches.

Included with this soil in mapping are small areas of Grable, Haynie, and Sarpy soils. The well drained Haynie and somewhat excessively drained Grable soils are in the slightly higher positions. Grable soils are silt loam and very fine sandy loam in the upper part and are sandy in the lower part. Haynie soils are silt loam and very fine sandy loam throughout. The excessively drained Sarpy soils are on narrow convex bars. They are sandy throughout. Also included are poorly drained soils in the lower areas in old stream channels that are subject to ponding. The soils in these areas are variable and are stratified with textures ranging from sand to clay. Included soils make up about 15 percent of the unit.

Important properties of the Leta soil—

Permeability: Slow in the upper part, moderate in the lower part
Surface runoff: Very slow
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: High in the upper part, low in the lower part
Depth to the water table: 1 to 3 feet

Most areas are used for cultivated crops. Some areas are wooded. This soil is suited to corn, soybeans, and small grain. The main management concerns are flooding and wetness. The flooding can delay planting and harvesting and reduce crop yields in some years.

Open ditches and shallow surface drains help to remove excess water. Some areas have been drained. In these areas, maintaining the present drainage system is needed for the efficient removal of excess water. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the spring. If this soil is tilled when wet, the seedbed becomes cloddy and cannot be easily managed. Tilling only when the soil is at the proper moisture content helps to minimize compaction and the formation of clods. Conservation tillage practices improve tilth in the surface layer. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to grasses and legumes for pasture. The main limitation is the wetness. Species that are tolerant of wetness, such as alsike clover, ladino clover, tall fescue, smooth brome, orchardgrass, and reed canarygrass, are best suited to this soil. Warm-season grasses, such as eastern gamagrass, switchgrass, and big bluestem, are well suited. Controlling grazing in wet areas helps to minimize compaction and helps to maintain a good sod cover. The soil generally is not used for hay crops because of the wetness. Surface drains and field ditches help to remove excess surface water.

This soil is suited to trees. Equipment limitations and seedling mortality are management concerns. Clayey soils have inadequate traction, low strength, and a moderate seedling mortality rate and can easily become compacted when wet. Ruts form easily on haul roads and skid trails, and the roads may be impassable during rainy periods. Harvesting and planting activities should be restricted to dry periods. Seedling survival can be improved by using mechanical or chemical weed-control methods, providing shade, mulching, or providing supplemental water. Planting containerized stock that has well developed root systems or reinforcement planting improves the seedling survival rate.

This soil is unsuited to building site development and onsite waste disposal systems because of the flooding. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

The land capability classification is IIIw. The woodland ordination symbol is 7W.

66—Leta silty clay, sandy substratum, rarely flooded. This deep, nearly level, somewhat poorly drained soil is on low flood plains along the Missouri River. The soil is protected by levees but is subject to flooding if the levees are broken or overtopped. Individual areas are irregular in shape and range from about 35 to 300 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 8 inches, black, firm silty clay

Subsurface layer:
8 to 12 inches, dark grayish brown, mottled, firm silty clay

Subsoil:
12 to 22 inches, dark grayish brown, mottled, firm silty clay

Substratum:
22 to 51 inches, stratified brown, grayish brown, and light gray, mottled, very friable silt loam and very fine sandy loam
51 to 60 inches, very dark grayish brown and white, mottled, loose fine sand

In places the surface layer is silty clay loam. In some areas the depth to the loamy horizon is less than 20 inches.

Included with this soil in mapping are some areas adjacent to the river channel that are frequently flooded and small areas of Grable, Haynie, and Sarpy soils. The somewhat excessively drained Grable soils are very fine sandy loam and silt loam in the upper part. They are in the higher areas. The well drained Haynie soils are in the slightly higher areas. They are silt loam and very fine sandy loam throughout. The excessively drained Sarpy soils are on narrow convex bars. They are sandy throughout. Also included are poorly drained soils in the lower areas in old stream channels that are subject to ponding. The soils in these areas are variable but are stratified with textures ranging from sand to clay. Included areas make up about 15 percent of the unit.

Important properties of the Leta soil—

Permeability: Slow in the upper part, moderate in the next part, very rapid in the lower part
Surface runoff: Very slow
Available water capacity: Moderate
Organic matter content: Moderate
Shrink-swell potential: High in the upper part, low in the lower part
Depth to the water table: 1 to 3 feet

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The main management concern is wetness. Open ditches and shallow surface drains help to remove excess water. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the spring. If this soil is tilled when wet, the seedbed becomes cloddy and cannot be easily managed. Tilling

only when the soil is at the proper moisture content helps to minimize compaction and the formation of clods. Conservation tillage practices improve tilth in the surface layer. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to grasses and legumes for pasture. The main limitation is the wetness. Species that are tolerant of wetness, such as alsike clover, ladino clover, tall fescue, smooth brome, orchardgrass, and reed canarygrass, are best suited to this soil. Warm-season grasses, such as eastern gamagrass, switchgrass, and big bluestem, are well suited. Controlling grazing in wet areas helps to minimize compaction and helps to maintain a good sod cover. The soil generally is not used for hay crops because of the wetness. Surface drains and field ditches help to remove excess surface water.

This soil is suited to trees. Equipment limitations and seedling mortality are management concerns. Clayey soils have inadequate traction, low strength, and a moderate seedling mortality rate and can easily become compacted when wet. Ruts form easily on haul roads and skid trails, and the roads may be impassable during rainy periods. Harvesting and planting activities should be restricted to dry periods. Seedling survival can be increased by using mechanical or chemical weed-control methods, providing shade, mulching, or providing supplemental water. Planting containerized stock that has well developed root systems or reinforcement planting also can improve the seedling survival rate.

This soil generally is not used for building site development or onsite waste disposal systems because of the flooding, the wetness, and the restricted permeability. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the shrink-swell potential, the potential for frost action, and the flooding are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action. Roads should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification is IIw. The woodland ordination symbol is 7C.

74—Sarpy loamy fine sand, rarely flooded. This very deep, nearly level, excessively drained soil is on low flood plains along the Missouri River. The soil is protected by levees but is subject to flooding if the levees are broken or overtopped. Individual areas are irregular in shape and range from about 15 to 200 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:

0 to 7 inches, very dark grayish brown, very friable loamy fine sand

Substratum:

7 to 60 inches, dark grayish brown and light brownish gray, loose fine sand

In some places the soil has thin layers of sandy loam, very fine sandy loam, and silt loam.

Included with this soil in mapping are areas of Grable, Haynie, and Kenmoor soils. The somewhat excessively drained Grable soils are in the slightly lower areas. They are silt loam and very fine sandy loam in the upper part. The well drained Haynie soils are in the slightly lower areas. They are silt loam and very fine sandy loam throughout. The moderately well drained Kenmoor soils are in the slightly lower areas. They are silty clay in the lower part. Included soils make up about 15 percent of the unit.

Important properties of the Sarpy soil—

Permeability: Rapid
Surface runoff: Very slow
Available water capacity: Low
Organic matter content: Low
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are wooded and are used for wildlife habitat or recreation. This soil is suited to cultivated crops on a limited basis. The main management concerns are the available water capacity and the hazard of wind erosion. Some type of irrigation generally is needed to sustain crop growth during dry periods. Maintaining a vegetative cover or surface mulch helps to control wind erosion.

This soil is suited to grasses and legumes that are tolerant of droughty soil conditions, such as crownvetch, lespedeza, eastern gamagrass, big bluestem, and switchgrass. The main concerns affecting pasture and hayland are the low available water capacity and the hazard of wind erosion. Irrigation can improve yields during dry periods and increases the selection of plant species that can be grown.

This soil is suited to trees. Equipment limitations and seedling mortality are management concerns. Sandy soils have inadequate traction, and ruts form easily during dry periods. Because of droughtiness, the

seedling mortality rate is high. Planting containerized stock that has well developed root systems, reinforcement planting when the soil is wet, and using special site preparation methods, such as furrowing or irrigation, can increase the seedling survival rate. Windblown sand may also damage young seedlings. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

This soil generally is not used for building site development or onsite waste disposal systems because of the flooding and a poor filtering capacity, which can result in the contamination of ground water. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

The land capability classification is IVs. The woodland ordination symbol is 3S.

75—Sarpy fine sand, frequently flooded. This very deep, nearly level, excessively drained soil is on low flood plains along the Missouri River between levees and the river channel. Individual areas are long and narrow and parallel to the river. They range from about 15 to 140 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 10 inches, dark brown, loose fine sand

Substratum:
10 to 60 inches, brown, loose sand and fine sand

In some places the soil has thin layers of loamy sand, very fine sandy loam, and silt loam.

Included with this soil in mapping are areas of Grable, Haynie, and Kenmoor soils. The somewhat excessively drained Grable soils are in the slightly lower areas. They are silt loam and very fine sandy loam in the upper part. The well drained Haynie soils are in the lower areas. They are silt loam and very fine sandy loam throughout. The moderately well drained Kenmoor soils are in the lower areas. They are silty clay in the lower part. Included soils make up about 15 percent of the unit.

Important properties of the Sarpy soil—

Permeability: Rapid
Surface runoff: Very slow
Available water capacity: Low
Organic matter content: Low
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are wooded and are used for wildlife habitat or recreation. This soil is suited to cultivated crops on a limited basis. The main management concerns are flooding, the available water capacity, and the hazard of wind erosion. Flooding can delay planting and harvesting and may reduce crop yields in some years. Some type of irrigation generally is needed to sustain crop growth during dry periods. Maintaining a vegetative cover or surface mulch helps to control wind erosion.

This soil is suited to grasses and legumes that are tolerant of droughty soil conditions, such as crownvetch, lespedeza, eastern gamagrass, big bluestem, and switchgrass. The main concerns affecting pasture and hayland are the low available water capacity and the hazard of wind erosion. Irrigation can improve yields during dry periods and increases the selection of plant species that can be grown.

This soil is suited to trees. Equipment limitations and seedling mortality are management concerns. Sandy soils have inadequate traction, and ruts can form easily during dry periods. Because of droughtiness, the seedling mortality rate is high. Windblown sand can damage seedlings and young trees. Planting containerized stock that has well developed root systems, reinforcement planting when the soil is wet, and using special site preparation methods, such as furrowing or irrigation, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

This soil is unsuited to building site development and onsite waste disposal systems because of the flooding.

The land capability classification is IVw. The woodland ordination symbol is 3S.

78D2—Shelby clay loam, 9 to 14 percent slopes, eroded. This very deep, strongly sloping, moderately well drained soil is on side slopes. Much of the original surface soil has eroded away. The present surface layer has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 5 to 200 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 8 inches, very dark grayish brown, firm clay loam

Subsoil:
8 to 39 inches, dark brown and yellowish brown, mottled, firm clay loam

Substratum:
39 to 60 inches, light brownish gray and yellowish brown, mottled, firm clay loam

In some places the upper part of the soil is silt loam or silty clay loam. In other places the subsoil is redder and has more clay.

Included with this soil in mapping are areas of Exira, Judson, and Lamoni soils and some severely eroded areas on shoulders. The well drained Exira soils are on concave head slopes and the upper side slopes above the Shelby soil. They are silty throughout. The well drained Judson soils are on foot slopes. They have a very thick, dark surface layer. The somewhat poorly drained Lamoni soils are on side slopes above the Shelby soil. They have more clay in the subsoil than the Shelby soil. Included areas make up about 15 percent of the unit.

Important properties of the Shelby soil—

Permeability: Moderately slow
Surface runoff: Rapid
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

Most areas are used for cultivated crops. A few areas are used as pasture or hayland. This soil is suited to corn, soybeans, and small grain. The main management concern is the hazard of erosion. In some areas, pebbles and cobbles on the surface can hinder planting and harvesting. Seeps or wet spots can form during times of high precipitation, but generally they do not limit agricultural operations. A conservation tillage system that leaves a protective cover of crop residue on the surface is very effective in controlling erosion. Most areas can be terraced and farmed on the contour. Constructing broad-base terraces or terraces that have steep back slopes along with grassed waterways or suitable tile outlets helps to control erosion. If exposed by terracing, the clayey subsoil cannot be easily tilled and is lower in fertility. In some areas the exposed subsoil can be covered with topsoil stockpiled from areas under construction. Terrace drains are generally needed because of the moderately slow permeability. Constructing grassed waterways helps to control erosion in drainageways and provides an outlet for terrace drains. Restricting fieldwork when the soil is wet minimizes soil compaction and cloddiness. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Erosion is a hazard during seedbed preparation. It can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements can minimize this problem. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

This soil is suited to building site development and sewage lagoons. The construction of dwellings is limited by the slope and the shrink-swell potential. Dwellings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping. Constructing footings, foundations, and basement walls with adequately reinforced concrete and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Installing drainage tile around footings minimizes the damage caused by wetness. The soil is unsuited to conventional septic tank absorption fields because of the restricted permeability. Sewage lagoons function adequately if the site can be leveled, or the sewage can be piped to adjoining areas of more favorable soils.

Low strength, the shrink-swell potential, the potential for frost action, and the slope are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling and by frost action. Roads can be designed so that they conform to the natural contour of the land. Some cut and fill may be necessary.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

79F—Timula-Knox silt loams, 14 to 35 percent slopes. This map unit consists of very deep, moderately steep or steep, well drained soils on upland side slopes adjacent to the Missouri River flood plain. Individual areas are irregular in shape and range from about 20 to 400 acres in size. This unit is about 65 percent Timula soil and 20 percent Knox soil. The two soils are in narrow bands and could not be mapped separately at the scale used.

The typical sequence, depth, and composition of the layers of the Timula soil are as follows—

Surface layer:
0 to 8 inches, dark brown, friable silt loam

Subsoil:
8 to 30 inches, brown and dark yellowish brown, friable silt loam

Substratum:
30 to 60 inches, brown and yellowish brown, friable silt loam

Important properties of the Timula soil—

Permeability: Moderate
Surface runoff: Very rapid
Available water capacity: High
Organic matter content: Moderately low
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

The typical sequence, depth, and composition of the layers of the Knox soil are as follows—

Surface layer:
0 to 7 inches, very dark grayish brown, friable silt loam

Subsoil:
7 to 39 inches, dark yellowish brown, firm silty clay loam and friable silt loam

Substratum:
39 to 60 inches, yellowish brown, friable silt loam

Important properties of the Knox soil—

Permeability: Moderate
Surface runoff: Very rapid
Available water capacity: High
Organic matter content: Moderate
Shrink-swell potential: Moderate
Depth to the water table: More than 6 feet

Included with the Timula and Knox soils in mapping are areas of Hamburg, Napier, Shelby, and Vanmeter soils. The somewhat excessively drained Hamburg soils are in the steeper areas. They are calcareous throughout. Napier soils are on foot slopes. They have a very thick, dark surface layer. The moderately well drained Shelby soils contain glacial sand and gravel. The moderately well drained Vanmeter soils are less than 40 inches deep to bedrock. Shelby and Vanmeter soils are on the lower back slopes below the Timula and Knox soils. Included soils make up about 5 to 10 percent of the unit.

Most areas are wooded. The main species are white oak, northern red oak, black oak, shagbark hickory, and sugar maple. Commercial timber harvest is limited, however, and the wooded areas are used mainly for wildlife habitat or recreation. A few of the less sloping areas are used for pasture, hay, or crops.

These soils generally are not used for cultivated crops because of the severe hazard of erosion. Only the included areas on foot slopes are suited to cultivated crops. Converting cropland to permanent vegetative cover, such as pasture, can help to control erosion in these areas.

Only the soils that have slopes of less than about 25 percent are suited to pasture renovation. These soils are suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Care is needed when pastures are reestablished because of the severe hazard of erosion. Pastures should be renovated only when necessary for the maintenance of production. Plants should be established in strips that follow the contour. Plowing and cultivation should be avoided. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

These soils are suited to trees. Equipment limitations and the erosion hazard are management concerns. The slope limits the use of equipment and increases the hazard of erosion. As the slope gradient increases, the use of wheeled equipment becomes more difficult. On the steeper slopes, track type equipment should be used. In the steepest areas, even the use of track type equipment may not be feasible. In these areas, it may be necessary to yard the logs uphill with cables. The number of suitable landing sites is very limited. Tree planting may be restricted to hand planting in areas where slopes are more than 35 percent. Constructing water bars and out-sloping road surfaces, adding culverts and drop structures, creating riparian buffer strips, seeding exposed areas, and locating haul roads and skid trails on the contour or on the gentler slopes help to prevent excessive soil loss.

These soils generally are not used for building site development or onsite waste disposal systems because of the slope. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

The land capability classification is VIe. The woodland ordination symbol is 4R.

80G—Timula-Hamburg silt loams, 14 to 90 percent slopes. This map unit consists of very deep, moderately steep to very steep soils on upland side slopes adjacent to the flood plain along the Missouri River. The Timula soil is well drained, and the Hamburg soil is somewhat excessively drained. Individual areas are irregular in shape and range from about 150 to 750 acres in size. This map unit is about 65 percent Timula soil and 20 percent Hamburg soil. The two soils are in narrow bands and could not be mapped separately at the scale used.

The typical sequence, depth, and composition of the layers of the Timula soil are as follows—

Surface layer:
0 to 7 inches, dark brown and very dark grayish brown, very friable silt loam

Subsoil:
7 to 20 inches, dark brown and brown, friable silt loam

Substratum:
20 to 60 inches, brown, very friable silt loam

Important properties of the Timula soil—

Permeability: Moderate
Surface runoff: Very rapid
Available water capacity: High
Organic matter content: Moderately low
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

The typical sequence, depth, and composition of the layers of the Hamburg soil are as follows—

Surface layer:
0 to 4 inches, dark brown, very friable silt loam

Subsurface layer:
4 to 14 inches, brown, very friable silt loam

Substratum:
14 to 25 inches, brown, very friable silt loam
25 to 60 inches, brown, mottled, very friable silt loam

Important properties of the Hamburg soil—

Permeability: Moderate
Surface runoff: Very rapid
Available water capacity: High
Organic matter content: Low
Shrink-swell potential: Low
Depth to the water table: More than 6 feet

In some areas the surface layer is very dark grayish brown silt loam about 10 inches thick.

Included with the Timula and Hamburg soils in mapping are areas of Napier, Shelby, and Vanmeter soils. Napier soils are on foot slopes. They have a very thick, dark surface layer. The moderately well drained Shelby soils are in the middle and lower positions on side slopes below the Timula and Hamburg soils. They contain glacial sand and gravel. The moderately well drained Vanmeter soils are on the lowest parts of back slopes below the Timula and Hamburg soils. They are less than 40 inches deep to bedrock. Included soils make up about 15 percent of the unit.

Most areas of this unit are wooded. The main species are white oak, northern red oak, black oak, shagbark hickory, and sugar maple. Commercial timber harvest is limited, however, and the wooded areas are used mainly for wildlife habitat or recreation. A few of the less sloping areas are used for pasture, hay, or crops.

These soils are unsuited to cultivated crops because of the severe hazard of erosion. Converting cropland to permanent vegetative cover, such as pasture, helps to control erosion in these areas.

The Timula soil is suited to pasture renovation only in areas that have slopes of less than about 25 percent. This soil is suited to most commonly grown grasses and legumes, such as alfalfa, ladino clover, red clover, reed canarygrass, smooth brome, tall fescue, big bluestem, indiangrass, and switchgrass. Care is needed when pastures are reestablished because of the severe hazard of erosion. Pastures should be renovated only when necessary for the maintenance of production. Plants should be established in strips that follow the contour. Plowing and cultivation should be avoided. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion.

The Timula and Hamburg soils are suited to trees. Equipment limitations and the erosion hazard are management concerns. The slope limits the use of equipment and increases the hazard of erosion. As the slope gradient increases, the use of wheeled equipment becomes more difficult. On the steeper slopes, track type equipment should be used. In the steepest areas, even the use of track type equipment may not be feasible. In these areas, it may be necessary to yard the logs uphill with cables. The number of suitable landing sites is very limited. Tree planting may be restricted to hand planting in areas where slopes are more than 35 percent. Constructing water bars and out-sloping road surfaces, adding culverts and drop structures, creating riparian buffer strips, seeding exposed areas, and locating haul roads and skid trails on the contour or on the gentler slopes help to prevent excessive soil loss.

These soils generally are not used for building site development, onsite waste disposal systems, or local roads and streets because of the slope. Dwellings and septic tank absorption fields should be located on the less sloping ridgetops and foot slopes within this unit. Onsite investigation may be needed to locate these areas.

The land capability classification of the Timula soil is VIe, and that of the Hamburg soil is VIIe. The woodland ordination symbol of the Timula soil is 4R, and that of the Hamburg soil is 2R.

81—Wabash silty clay, rarely flooded. This very deep, nearly level, poorly drained soil is on high flood plains along the Missouri River. The soil is protected by

levees but is subject to flooding if the levees are broken or overtopped. Individual areas are irregular in shape and range from about 150 to 2,200 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 6 inches, black, very firm silty clay

Subsurface layer:
6 to 12 inches, black, very firm silty clay
12 to 34 inches, black, mottled, very firm silty clay

Subsoil:
34 to 60 inches, very dark gray and dark gray, mottled, very firm clay

In places the surface layer is silty clay loam.

Included with this soil in mapping are areas of the somewhat poorly drained Blencoe, Dockery, and Dupo soils. Blencoe soils have loamy and silty material below a depth of 25 inches. They are in the slightly higher areas. Dockery soils are adjacent to old stream channels. They have less clay in the upper part than the Wabash soil. Dupo soils are silt loam in the upper part. They are in the slightly higher areas. Included soils make up about 10 percent of the unit.

Important properties of the Wabash soil—

Permeability: Very slow
Surface runoff: Very slow
Available water capacity: Moderate
Organic matter content: Moderate
Shrink-swell potential: Very high
Seasonal high water table: At the surface to 1 foot below the surface

Most areas are used for cultivated crops. A few areas are flooded during the fall migration of waterfowl and are used for hunting. This soil is suited to corn, soybeans, and small grain. The main management concern is wetness. Open ditches and shallow surface drains help to remove excess water. Many areas have been drained. In these areas, maintaining the present drainage system is needed for the efficient removal of excess water. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the spring. If this soil is tilled when wet, the seedbed becomes cloddy and cannot be easily managed. Tilling only when the soil is at the proper moisture content helps to minimize compaction and the formation of clods. Conservation tillage practices improve tilth in the surface layer. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to grasses and legumes for pasture. The main limitation is the wetness. Species that are tolerant of wetness, such as alsike clover, ladino clover, tall fescue, smooth brome, orchardgrass, and reed canarygrass, are best suited to this soil. Warm-season grasses, such as eastern gamagrass, switchgrass, and big bluestem, are well suited. Controlling grazing in wet areas helps to minimize compaction and helps to maintain a good sod cover. The soil generally is not used for hay crops because of the wetness. Surface drains and field ditches help to remove excess surface water.

This soil is suited to trees. Equipment limitations and seedling mortality are major concerns. Clayey soils have inadequate traction and low strength and can easily become compacted when wet. Ruts form easily on haul roads and skid trails, and the roads may be impassable during rainy periods. Planting and harvesting activities should be restricted to dry periods. Seedling survival rates can be improved by using mechanical or chemical weed-control methods, providing shade, or mulching. Planting containerized stock that has well developed root systems or reinforcement planting increases the seedling survival rate.

This soil generally is not used for building site development, onsite waste disposal systems, or local roads and streets because of the flooding, the wetness, the restricted permeability, and the high shrink-swell potential. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

The land capability classification is IIIw. The woodland ordination symbol is 4W.

82—Zook silty clay loam, occasionally flooded. This very deep, nearly level, poorly drained soil is on low flood plains along intermediate-sized streams. Some areas of this soil are protected from low-level floods by levees but are subject to flooding if the levees are broken or overtopped. Individual areas are irregular in shape and range from about 5 to 70 acres in size.

The typical sequence, depth, and composition of the layers of this soil are as follows—

Surface layer:
0 to 9 inches, black, firm silty clay loam

Subsurface layer:
9 to 34 inches, black and very dark gray, firm silty clay loam and silty clay

Subsoil:
34 to 60 inches, very dark gray, mottled, firm silty clay

Included with this soil in mapping are areas of very poorly drained soils that are subject to ponding. These

soils make up about 10 percent of the unit.

Important properties of the Zook soil—

Permeability: Moderately slow in the upper part, slow in the lower part
Surface runoff: Very slow
Available water capacity: High
Organic matter content: High
Shrink-swell potential: High
Seasonal high water table: At the surface to 3 feet below the surface

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The main management concerns are wetness and the occasional flooding. Open ditches and shallow surface drains help to remove excess water. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the spring. Planting and harvesting are delayed in some years because of the flooding. If this soil is tilled when wet, the seedbed becomes cloddy and cannot be easily managed. Tilling only when the soil is at the proper moisture content helps to minimize compaction and the formation of clods. Conservation tillage practices improve tilth in the surface layer. Returning crop residue and other organic material to the soil improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to grasses and legumes for pasture. The main limitation is the wetness. Species that are tolerant of wetness, such as alsike clover, ladino clover, tall fescue, smooth brome, orchardgrass, and reed canarygrass, are best suited to this soil. Warm-season grasses, such as eastern gamagrass, switchgrass, and big bluestem, are well suited. Controlling grazing in wet areas helps to minimize compaction and helps to maintain a good sod cover. The soil generally is not used for hay crops because of the wetness. Surface drains and field ditches help to remove excess surface water.

This soil is unsuited to building site development and onsite waste disposal systems because of the flooding, the wetness, the restricted permeability, and the high shrink-swell potential. Dwellings and septic tank absorption fields should be constructed in areas of more favorable soils.

Low strength, the high shrink-swell potential, the potential for frost action, the wetness, and the flooding are limitations on sites for local roads and streets. Adding crushed rock or other suitable base material minimizes the damage caused by low strength. Grading the roads so that they shed water, constructing roadside ditches, and installing culverts improve drainage and thus help to prevent the damage caused by shrinking and swelling, frost action, and wetness. Roads should be constructed on raised, well compacted fill material above known flood levels.

The land capability classification is IIw. No woodland ordination symbol is assigned.

84—Udifluvents, frequently flooded. This map unit consists of borrow pits intermingled with areas of natural soils. Most of these areas parallel the Missouri River and are frequently flooded. The material excavated from the pits was used in the construction of levees. Ponding occurs in the pits following rainfall and when the water level of the river is high. The areas typically are rectangular and range from about 5 to 30 acres in size.

The Udifluvents are sandy to clayey, alluvial soils on the bottom of borrow pits. Permeability and available water capacity vary widely in these soils. The content of organic matter is low, and the water table commonly is within a depth of 6 feet.

Included in mapping are small areas of the excessively drained Grable soils, the well drained Haynie soils, and the somewhat poorly drained Leta soils. These included soils are in areas between the borrow pits. They make up about 10 to 15 percent of the unit.

Most areas of this unit are idle land. The vegetation on the Udifluvents is mostly water-tolerant weeds and trees. The ponding and the extreme variability of the soil material are the major management concerns affecting most uses.

No land capability classification or woodland ordination symbol is assigned.

85—Pits, quarries. This map unit consists of open excavations from which soil material has been removed and from which the underlying limestone bedrock has been mined. A typical quarry has a vertical face or exposure 10 to more than 50 feet high on three sides. The areas are made up of the limestone being quarried and the overlying formations of shale and limestone. The overburden of glacial material and loess above the vertical rock face is 10 to 20 feet thick in most places. The overburden is removed and stockpiled in an undisturbed adjacent area or placed in previously mined pits. The floor of the pits is generally nearly level.

About 50 percent of the unit consists of rubble and spoil piles, about 15 percent consists of packed roadways and stockpiles of gravel and lime, and about 10 percent is the active pit area. Areas of rubble and spoil are rough and broken and consist of loamy and clayey material with varying amounts of limestone and shale fragments, and they include open pit areas filled with water. Some areas are sparsely covered with weeds, brush, and young hardwoods.

Most areas of this unit are no longer quarried, but limestone is being removed from a few of the excavations. The unit is not suitable as cropland or pasture. It is best suited to wildlife habitat or recreational uses.

No land capability classification or woodland ordination symbol is assigned.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

About 15,120 acres in the survey area, or nearly 5 percent of the total acreage, meets the soil requirements for prime farmland. An additional 137,936 acres meets the requirements in areas where the soils are drained or protected from flooding. Most of the prime farmland is used for crops, mainly corn, soybeans, winter wheat, and grain sorghum.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps that accompany this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table and all soils that are frequently flooded during the growing season qualify as prime farmland only in areas where these limitations have been overcome by drainage measures or flood control. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not these limitations have been overcome by corrective measures. Many of the naturally wet soils in Holt County have been adequately drained.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Natural Resources Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under the heading "Detailed Soil Map Units." Specific information can be obtained from the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

Because of its favorable climate and fertile soils, Holt County ranked fifth in corn production and eighth in soybean production in Missouri in 1990. Approximately 192,800 acres, or 65 percent of the county, was used for cultivated crops. Of this total, 82,300 acres of corn, 94,700 acres of soybeans, 1,800 acres of grain sorghum, and 7,500 acres of winter wheat was harvested. The acreage used for hay was 6,500. The remaining cropland is used for conservation purposes or is not presently in production. The average farm size was 383 acres in 1982. There were 14,300 cows and 20,100 hogs and pigs in the county, and several large chicken houses produced stock for canned goods (Missouri Department of Agriculture, 1991).

The potential of the soils in Holt County for sustained production of food is good. Sustained agricultural production is possible on more than 90 percent of the soils in the county, although careful management is necessary on much of the land. Erosion on most of the cropland can be held to tolerable limits by a system of conservation practices designed for specific sites. Some of the marginal cropland used for row crops should be converted to pasture or hayland.

Water erosion is the major obstacle to sustaining long-term productivity on the upland soils in Holt County. All soils that have slopes of more than 2 percent are susceptible to erosion.

Loss of the surface layer through erosion is damaging for two reasons. First, yields are reduced when the surface layer is lost and part of the subsoil is incorporated into the plow layer. Slowly released

nutrients are removed and must be replaced. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Lamoni and Shelby soils, because a good seedbed cannot be easily prepared. Second, erosion on farmland can result in the pollution of streams, lakes, and ponds by fertilizer and pesticides and can accelerate the rate of sedimentation. Controlling erosion minimizes this pollution and improves the quality of water for municipal and recreational uses and for fish and wildlife. Erosion control also prolongs the usefulness of ponds and lakes by helping to prevent them from filling up with sediment.

Erosion-control practices protect the soil surface, help to control runoff, and increase the rate of water infiltration. A no-till or minimum till cropping system that maintains a cover of crop residue on the surface can hold erosion losses to amounts that will not reduce the productive capacity of the soils. Growing grasses and legumes for pasture and hay is very effective in controlling erosion. Including legumes, such as clover and alfalfa, in crop rotations also improves tilth and provides nitrogen for the following crop. Farming on the contour and contour stripcropping also help to control erosion. Contour stripcropping involves maintaining a permanent cover of grasses or legumes in strips that follow the contour of the land. The grasses or legumes generally are used for hay. The areas between the strips are cropped on the contour. Grade-stabilization structures and waterways are effective in controlling erosion in gullied areas and can serve as outlets for terraces and contour systems.

Terraces are important erosion-control measures in Holt County (fig. 7). They can be used to reduce the length of slopes and to control runoff and erosion. Broad-base terraces are suitable in areas that have slopes of less than 12 percent. The entire terrace can be tilled. Because broad-base terraces increase the slope gradient, additional erosion-control measures are crucial. Narrow-base terraces and terraces that have steep back slopes are best suited in areas that have slopes of more than 12 percent. These designs reduce the gradient of the slopes. The strongly sloping Exira, Marshall, Monona, Contrary, Timula, Lamoni, and Shelby soils are suited to terrace systems. Special construction and management techniques are necessary if terrace systems are to be effective.

Soil drainage and flood control are management concerns on about 130,000 acres in Holt County. Blencoe, Colo, Dockery, Dupo, Kenmoor, Leta, Luton, and Wabash soils are limited by wetness. The wetness can delay planting and harvesting and may reduce crop production during some part of most years. Many areas of these soils have been drained. Maintaining the present drainage system is necessary for the continued efficient removal of excess water. Drainage lowers the water table, increases the rooting depth, and allows the soil to warm more quickly in the spring.

Most of the soils on the flood plain along the Missouri River are protected from low and moderate flooding levels by a system of levees that run parallel to the river. The major tributaries that cross the flood plain also have limited protection. The soils in these areas are subject to rare flooding if the levees break or are overtopped. The soils on the river side of the levees are frequently flooded. Occasional flooding can be a problem on Colo, Kenridge, Nodaway, and Motark soils. These soils are on the flood plains along creeks that pass through the uplands on their way to the Missouri River. Much of the Nodaway River flood plain, from just below Maitland to where the Nodaway River empties into the Missouri River, has a levee system that offers limited protection. This area is subject to flooding if the levees break or are overtopped.

The natural fertility of the soils in Holt County is high. The eroded soils naturally are lower in fertility than the uneroded soils. Adequate fertility is important in maintaining high yields over a period of years, and all soils need additional plant nutrients, notably nitrogen, phosphorus, and potassium. Many commercial nitrogen fertilizers tend to acidify the soil, and lime is commonly added to counteract this effect. The kinds and amounts of lime and fertilizer required vary, depending on the type of soil, the crop, the level of production desired, and past management practices. On all soils, additions of lime and fertilizer should be based on the results of soil tests. The Cooperative Extension Service can help in determining the kinds and amounts of lime and fertilizer to be applied.

Soil tilth is an important factor in the germination of seeds and the infiltration of water into the soil. Soils that have good tilth are granular and porous. Most of the uneroded upland soils used for crops have a surface layer of silt loam or silty clay loam that is dark and has a moderate or high content of organic matter. Generally, the structure of soils that have a surface layer of silt loam is weakened by tillage and compaction. A crust forms on the surface of these soils during periods of heavy rainfall. Because it is hard when dry, the crust reduces the rate of water infiltration and increases the runoff rate.

All of the eroded upland soils in the county have a higher content of clay in the surface layer than the uneroded soils. As a result, tilth is poorer and the infiltration rate is slower. Lamoni and Shelby soils are most affected by poor tilth because of a clayey subsoil. Regular additions of crop residue, manure, and other organic material to these soils can improve soil structure and tilth. Conservation practices also are

Figure 7.—A terrace in an area of Timula silt loam, 9 to 14 percent slopes, severely eroded.

needed to minimize further erosion on these soils.

Fall tillage of upland soils causes surface crusting, which increases the runoff rate and the hazard of erosion. Most areas of cropland in the uplands consist of sloping soils that are subject to damaging erosion if plowed in the fall.

Tilth is a problem in areas of Blencoe, Leta, Luton, and Wabash soils. If they are tilled when wet, these soils tend to be cloddy when they dry. As a result of the cloddy condition, seedbed preparation is difficult. Plowing these soils in the fall generally results in better tilth.

A few center-pivot irrigation systems are utilized in the county. They are on the Missouri River flood plain, where water is available. These systems increase yields by supplying supplemental water during critical periods of crop growth. Some landowners use diverted water from streams that cross the flood plain during high flow periods to irrigate fields in the fall.

Pasture and hay crops suited to the soils and climate of the county are legumes, cool-season grasses, and warm-season native grasses. In 1990, about 10,100 acres in Holt County was used for hay and pasture (fig. 8). Alfalfa and red clover are the most common legumes, and smooth brome, orchardgrass, and bluegrass are the most common grasses. Mixtures of grasses and legumes also are grown for hay and pasture. Water-tolerant species, such as alsike clover, ladino clover, bluegrass, and timothy, should be selected for planting on the poorly drained Colo, Luton, Wabash, and Zook soils.

Warm-season native grasses adapted to the county are big bluestem, indiangrass, and switchgrass. These grasses grow well during the hot summer months, when cool-season grasses are dormant and of low nutritional quality. Different management techniques are needed for establishing and grazing these grasses than for establishing and grazing cool-season grasses.

Figure 8.—Alfalfa hay grown on the contour in an area of Contrary silt loam, 9 to 14 percent slopes, eroded. Using grasses and legumes in rotation with other crops helps to control erosion.

The major management concerns on upland soils is the hazard of erosion during seedbed preparation. Erosion can be minimized by tilling on the contour and by timing tillage so that a good ground cover is quickly established. Livestock trails and overgrazed areas are subject to erosion. Careful placement of livestock water and supplements helps to prevent erosion in these areas. Deferred grazing, rotation grazing, and proper stocking rates increase the carrying capacity of pastures and help to control erosion. Grazing when the soils are too wet causes surface compaction and reduces the rate of water infiltration.

Yields per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and

results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Natural Resources Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland or for engineering purposes.

In the capability system, soils are generally grouped at three levels—capability class, subclass, and unit (USDA, 1961). Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

The capability classification of the map units in this survey area is given in the section "Detailed Soil Map Units" and in the yields table.

Woodland Management and Productivity

Douglas C. Wallace, forester, Natural Resources Conservation Service, helped prepare this section.

According to estimates by the Missouri Department of Conservation, approximately 7 percent of Holt County, or about 21,000 acres, was forested in 1986. Upland woodland tracts in the county are primarily small, private holdings of 10 to 50 acres and are essentially unmanaged (Geissman and others, 1986). Larger continuous tracts of timber are on the hills along the flood plains of the Missouri and Nodaway Rivers. Woodlands on flood plains are mostly long, narrow bands bordering streams and rivers. Several larger tracts are in wildlife refuge areas.

Tree species and growth rates in the county vary, depending on soil properties, site characteristics, and past management.

Soil properties that affect the growth of trees include reaction (pH), fertility, drainage, texture, structure, and soil depth. The soil also serves as a reservoir for moisture, provides an anchor for roots, and supplies essential plant nutrients. Soils in which these properties are not extreme and that have an effective rooting depth of more than 40 inches provide the best medium for timber production.

Site characteristics that affect tree growth include aspect, slope, and topographic position. These site characteristics influence the amount of available sunlight, air drainage, soil temperature, soil moisture, and relative humidity. Generally, north and east aspects and the lower slope positions, which are cooler and have better moisture conditions, are the best upland sites for tree growth. The most productive bottom-land soils are generally deep, moderately well drained, and only occasionally flooded.

Management activities can influence woodland productivity and should be aimed at eliminating factors that cause tree stress. Generally, such management includes thinning overstocked young stands; harvesting old, mature trees; and preventing destructive fire and grazing by livestock. Fire and grazing have very negative impacts on forest growth and quality. Although forest fires are no longer a major problem in the county, about 50 percent of the woodland is still subject to grazing. Grazing destroys the leaf layer on the surface, compacts the soil, and kills or damages tree seedlings. Woodland sites that have not been grazed or burned have the highest potential for optimum timber production.

Timula, Knox, Vanmeter, and Hamburg soils on the hills of the flood plains along the Missouri and Nodaway Rivers have the largest acreages of upland forest. Typical species are white oak, northern red oak, black oak, and sugar maple. Post oak, black oak, shagbark hickory, and blackjack oak grow on the coarser textured, droughty soils in these areas. Undisturbed forested areas of Knox and Timula soils are very productive.

Along the major watercourses, Leta, Haynie, Grable, Sarpy, and Nodaway soils support bottom-land hardwoods adapted to wet or flooded soil conditions. Most of these sites have been cleared for crop production. The remaining wooded areas typically support silver maple, hackberry, American elm, swamp white oak, sycamore, cottonwood, and pin oak. Bur oak, shellbark hickory, and walnut are common on bottom land along the smaller streams and on the higher terraces of the major streams. A high potential for excellent timber growth exists on these sites.

Specialty tree plantings, such as Christmas trees, nut trees, and fuelwood trees, can be very successful if adapted species are used. Christmas tree plantings can be established on any soil that is not poorly drained or very poorly drained. Species of trees suited to the soils in Holt County include Scotch pine, Austrian pine, white pine, and Douglas-fir. Nut trees, such as black walnut, are best suited to deep, loamy, moderately well drained or well drained soils, such as Marshall and Knox soils in the uplands and Haynie and Nodaway soils on the flood plains. Other soils are also suited but may be less productive than the soils in these areas. Tree plantations for fuelwood utilizing fast-growing species are feasible in Holt County. The species most adaptable for this purpose are green ash, black locust, sycamore, and silver maple.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; *F*, a high content of rock fragments in the soil; and *N*, snowpack. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, F, and N.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, and fire lanes and in log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that

erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment and season of use are not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. The site index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic feet per acre per year, indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand.

The first species listed under *common trees* for a soil is the indicator species for that soil. It generally is the most common species on the soil and is the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Windbreaks and Environmental Plantings

Douglas C. Wallace, forester, Natural Resources Conservation Service, helped prepare this section.

Living plants play an important role in supporting our life and improving its condition. When properly used and maintained, plants provide positive solutions to problems in our contemporary environment. In Holt County, windbreaks and environmental plantings can be utilized throughout the landscape for a variety of engineering, climatological, and esthetic purposes.

Windbreaks can be grown successfully in most areas of Holt County. Some important considerations affecting the management of farmstead and field windbreaks are design and layout, species selection, site preparation, seedling handling, weed management, supplemental watering, and protection from diseases, insects, and livestock.

Farmstead windbreaks make the farmstead more comfortable, reduce energy costs, increase yields from gardens and fruit trees, enhance wildlife populations, buffer noises, and increase property values (Scholten, 1988).

Feedlot windbreaks can be used to protect livestock from wind and snow. Windbreaks significantly minimize calf losses, make feeding easier, and enable livestock to maintain better weight with less feed.

Farmstead and feedlot windbreaks are generally three or more rows deep and include at least two rows of coniferous trees. The windbreaks should be established on the windward side of the area to be protected and should be at right angles to the prevailing winds. Well designed farmstead and feedlot windbreaks

are needed in Holt County, especially in the open areas of former prairie soils, such as those in the Timula-Monona-Napier, Marshall-Contrary, Monona-Timula-Contrary, and Marshall-Exira-Shelby associations, which are described under the heading "General Soil Map Units."

Field windbreaks or shelterbelts protect field crops and areas of bare soil from the effects of strong winds. Field windbreaks minimize soil losses, increase crop yields, help to prevent the spread of weeds, and enhance wildlife populations (Brandle and others, 1988). Careful planning is needed. Field boundaries, irrigation systems, power lines, and roads should be considered when the location of field windbreaks is determined. Windbreaks should be oriented at right angles to the prevailing winds. A typical field windbreak system consists of a series of single rows of trees or shrubs. Field windbreaks are adaptable to many locations in Holt County but are most beneficial in areas of the Leta-Grable-Haynie association.

Environmental plantings can be used for beautification, as visual screens, and for control of acoustical and climatological problems around buildings and other living spaces. Plants whose height, shape, color, and texture are compatible with the surrounding area, structures, and desired use should be selected (Robinette, 1972). Trees and shrubs can be easily established in most parts of Holt County if proper site preparation methods are applied and weeds and other competing vegetation are controlled.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Natural Resources Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Big Lake State Park provides multiple recreational facilities for the residents of Holt County. The 615-acre lake is a natural oxbow formed by the Missouri River before its course was controlled by channelization. The park offers opportunities for boating, fishing, swimming, and bird watching. Lodging, cabins, and camping and picnicking facilities are also available.

Recreational activities related to wildlife and wildlife habitat are also abundant in the county. The Squaw Creek National Wildlife Refuge provides excellent opportunities for viewing wildlife in natural settings. Migratory ducks and geese stop in this area during their fall and spring migrations. Eagles, pelicans, and herons can also be observed. The refuge is home to many species of mammals, reptiles, and amphibians. The Missouri Department of Conservation provides areas for wildlife viewing, for recreational activities, and for hunting during the appropriate seasons. The Bob Brown and H.F. Thurnau Wildlife Areas are on the flood plain along the Missouri River. The Payne Landing area provides access to the river for fishing. The River Breaks State Forest and the Monkey Mountain and Jamerson C. McCormack Conservation Areas provide access to woodland areas. Also, many landowners lease pits for hunting during the fall migration of ducks and geese.

Other recreational facilities include a public swimming pool, picnic area, and nine-hole golf course in Mound City and a public swimming pool in Oregon. Mound City has restored the State Theater, in which various events are produced sponsored by the State Theater Arts Council.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements

and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils are gently sloping and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Bill White, wildlife services biologist, Missouri Department of Conservation, helped prepare this section.

Prior to settlement, about 58 percent of Holt County was prairie (Schroeder, 1982). Prairie and prairie marshes made up about one-third of the flood plain along the Missouri River. Large tracts of cordgrass, sedges, and cattails grew primarily on the clayey soils, such as Luton and Wabash soils, from the Squaw Creek Refuge northwest through Craig and Corning. The rest of the flood plain, mainly areas of Leta, Haynie, and Grable soils, was timbered. The prairie dominated the uplands and was made up of the Marshall-Contrary and Marshall-Exira-Shelby associations, which are described under the heading "General Soil Map Units." Grasses on this prairie included big bluestem and indiangrass. The very steep western exposure of Hamburg soils in the Missouri River hills supported sideoats grama, little bluestem, and abundant wildflowers.

Woodlands were extensive along the Nodaway River and the adjacent uplands and in the hills extending from southeast of the community of Napier to the Nodaway River. The major soils in these areas are Timula, Knox, and Vanmeter soils. Woodlands were also along the smaller upland streams throughout the county. This diverse pattern of prairie and woodland was a major factor in the abundance of wildlife in presettlement Holt County.

Nearly all of the naturally occurring prairie and some of the woodland in Holt County is now used as cropland or for pasture, which is dominated by introduced grasses. Scattered remnants of prairie are in old cemeteries and undisturbed fields and along the hills adjacent to the Missouri River flood plain. These remnant prairie areas are unique and contain several plant species that are rarely found in Missouri. This type of Missouri prairie is left only in Holt and Atchison Counties. Proper management, including rotation grazing and prescribed burning, is needed to maintain this unusual plant community.

In 1987, about 7 percent of Holt County was wooded (Missouri Department of Conservation, 1988). Wooded areas remain in the Missouri River hills and in the hills along the southern reaches of the Nodaway River. Most of the wooded areas on the flood plain along the Missouri and Nodaway Rivers have been cleared. Channelization of rivers and creeks and siltation have destroyed many of the wetlands and fisheries in the county.

Holt County has five large public-use areas that are managed for wildlife and forest resources. The Bob Brown Wildlife Area is a wetland development on the bottom land along the Missouri River. The Squaw Creek National Wildlife Refuge is a natural wetland that provides habitat for migratory birds. Big Lake State Park, in addition to the lake, has a large natural oxbow wetland that is managed as a natural area. The River Breaks State Forest is an oak-hickory woodland in the Missouri River hills. The Monkey Mountain Wildlife Area overlooks the Nodaway River and includes a variety of wooded and open habitats. The Jamerson C. McCormack Conservation Area features mixed prairies and woodlands overlooking the Squaw Creek Refuge. The H.F. Thurnau Wildlife Area and Payne Landing

provide recreational access to the Missouri River.

The most common presettlement wildlife included bison, red wolf, elk, white-tailed deer, and prairie chicken. Destruction of the prairies has eliminated all but the white-tailed deer. Other wildlife species, such as coyotes and ring-necked pheasant, have adapted to the new land uses. Because of the wetlands in the area, waterfowl and other migratory birds have been of significant importance.

Holt County supports more species of fish and wildlife than any other county in northwestern Missouri (Meyer, 1991). There are 356 known fish and wildlife species in the county. This large number of species is a result of the Missouri River and the Squaw Creek Refuge. Twenty-three rare and endangered species have been identified in the county. Among these are the bald eagle, the barn owl, the least tern, and the river otter.

Hunting is an important recreational activity in the county. Waterfowl, deer, pheasant, and quail are the most sought-after game. Excellent turkey hunting is available in the wooded hills along the Missouri and Nodaway Rivers. Furbearers harvested include opossum, muskrat, raccoon, coyote, and beaver.

Holt County is a stopping area for an enormous number of migratory waterfowl and wading birds. It is along the Mississippi Flyway. As many as 400,000 snow geese and blue geese and more than 50,000 ducks use the Squaw Creek Refuge and surrounding wetlands during the month of November. The geese and ducks rest at the refuge and feed on waste grain and winter wheat on the flood plain and in the uplands. Bald eagles also migrate with the waterfowl, and as many as 400 eagles can be seen at the refuge during the peak of the migration. The eagles feed on sick and dying waterfowl.

Commercial and sport fishing for carp, channel catfish, and buffalo are common in the Missouri River. Carp and catfish are also in the Nodaway River. Game fish, such as largemouth bass, bluegill, and crappie, are in area lakes and ponds and in some streams.

Several wildlife species are presently being restored in Missouri. Of these, three releases are close enough to have an influence in Holt County (USDA, National Resources Inventory).

River otters have been released in Platte County, along the Missouri River. Otters are transient and travel great distances, and thus they may become established in Holt County. Riparian zones and wetlands adjacent to major drainageways provide habitat for the river otter.

The giant Canada goose of the eastern prairie population is being expanded in Missouri. In 1987, young birds were relocated to Nodaway Lake in Nodaway County. Holt County is within the 20-mile zone of influence for this release. Canada geese are currently nesting at Big Lake State Park.

Ruffed grouse were released in and around Holt County in the early 1980's. Inadequate forest management practices have eliminated most of the traditional habitat for this species. No birds have been sighted in the area recently.

All game species respond favorably to habitat development and management. Pheasants and quail have adapted to intensive agricultural land use and respond well to conservation cropping systems. In particular, the use of native prairie grasses on terraces that have steep back slopes and on narrow-base terraces, in grassed waterways, in field borders, and in stripcropping systems provides important nesting and roosting areas. Trees and brush can be maintained along field borders, roads, and ditches and in other unfarmed areas as winter cover. Preserving hedgerows enhances wildlife habitat and can also increase crop yields by keeping snow on the fields in winter and by reducing the effects of hot, dry winds in summer. Root plowing can minimize the sapping effect on adjacent crops.

Maintaining forested buffer strips along streams helps to stabilize streambanks and provides valuable cover for woodland wildlife and for beaver and river otter. Preserving the remaining wetlands and developing new wetlands are needed to provide feeding and resting stops for migratory waterfowl.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places.

Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and soybeans.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flooding, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. Wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. Ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils

may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrinking and swelling, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfill. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation should be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench landfills. Unless otherwise stated, the

ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as the final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet and have a water table at a depth of less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil

texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal high water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and the potential for frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, and sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind erosion or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts and sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

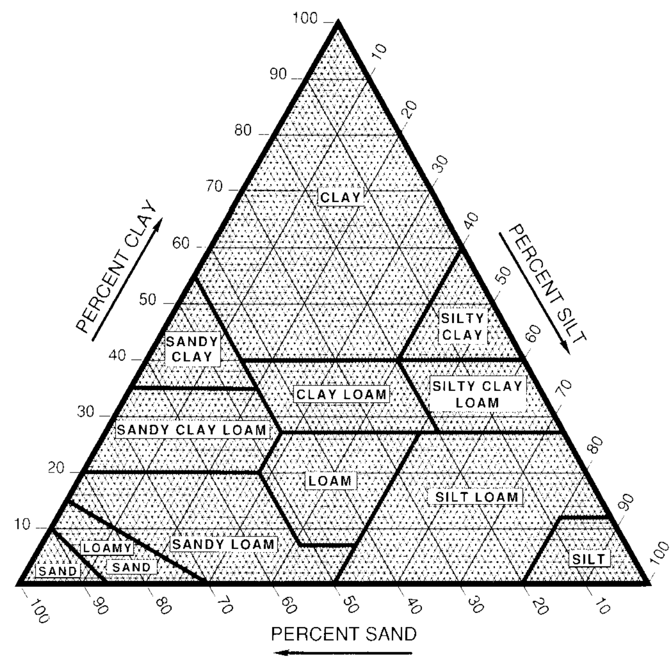

Figure 9.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under the heading "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 9). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (ASTM, 1993) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 1986).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and

clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓-bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops

and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist

mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 17, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs often under normal weather conditions (the chance of flooding is more than 50 percent in any year). Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone. Only saturated zones within a depth of about 6 feet are indicated.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium

content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (USDA, 1975). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that has an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. An example is Vertic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, montmorillonitic, mesic Vertic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" (USDA, 1993). Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" (USDA, 1975). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Blencoe Series

The Blencoe series consists of very deep, nearly level, somewhat poorly drained soils on high flood plains along the Missouri River. These soils formed in clayey and loamy alluvium. Permeability is slow in the upper part of the profile and moderate in the lower part.

Slopes range from 0 to 2 percent.

Typical pedon of Blencoe silty clay, rarely flooded, 50 feet south and 50 feet west of the northeast corner of sec. 6, T. 58 N., R. 37 W.

Ap—0 to 10 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine angular blocky structure; firm; neutral; clear smooth boundary.

AB—10 to 20 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; common fine prominent strong brown (7.5YR 5/6) mottles in the lower part; strong fine subangular blocky structure; firm; neutral; clear smooth boundary.

Bw—20 to 28 inches; dark grayish brown (10YR 4/2) silty clay; common fine prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; neutral; abrupt smooth boundary.

2Cg1—28 to 40 inches; dark grayish brown (10YR 4/2) silt loam; few fine prominent strong brown (7.5YR 5/6) and common medium distinct grayish brown (10YR 5/2) mottles; massive; friable; slightly effervescent; slightly alkaline; gradual smooth boundary.

2Cg2—40 to 60 inches; grayish brown (10YR 5/2) silt loam; common fine prominent strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) mottles; massive with many fine to coarse bedding planes; friable; slightly effervescent; slightly alkaline.

The thickness of the solum and the depth to carbonates range from 25 to 40 inches. The Ap or A horizon has value of 2 or 3 and chroma of 1 or 2. The AB or BA horizon has colors similar to those of the A horizon. The Bw horizon has hue of 10YR or 2.5YR and value of 4 or 5. It is silty clay loam or silty clay. The 2Cg horizon has hue of 10YR or 2.5Y and value of 4 or 5.

Colo Series

The Colo series consists of very deep, poorly drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Colo silty clay loam, occasionally flooded, 1,400 feet north and 1,250 feet east of the southwest corner of sec. 2, T. 61 N., R. 37 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

A1—9 to 20 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; few fine prominent strong brown (7.5YR 5/8) mottles; moderate fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A2—20 to 27 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; common fine prominent strong brown (7.5YR 5/8) mottles; moderate medium subangular blocky structure; friable; slightly acid; gradual wavy boundary.

Bg—27 to 50 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; many fine and medium prominent strong brown (7.5YR 5/8) mottles; moderate medium subangular blocky structure; firm; neutral; gradual wavy boundary.

BCg—50 to 60 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (5Y 4/1) dry; many fine and medium prominent strong brown (7.5YR 5/8) mottles; moderate medium subangular structure; firm; neutral.

The mollic epipedon is more than 40 inches thick. Some pedons have overwash sediments as much as 12 inches thick. These sediments have hue of 10YR, value of 2 to 4, and chroma of 1 to 3. The Ap and A horizons have hue of 10YR or 2.5Y or are neutral in hue. They have value of 2 or 3 and chroma of 0 to 2. The Bg horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 to 4 and chroma of 0 to 2.

Contrary Series

The Contrary series consists of very deep, well drained, moderately permeable soils on uplands. These soils formed in thick loess. Slopes range from 9 to 14 percent.

Typical pedon of Contrary silt loam, 9 to 14 percent slopes, eroded, 1,600 feet east and 1,200 feet south of the northwest corner of sec. 20, T. 60 N., R. 37 W.

Ap—0 to 5 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine granular structure; firm; slightly acid; clear smooth boundary.

Bw1—5 to 10 inches; dark yellowish brown (10YR 4/4) silt loam; few fine distinct grayish brown (10YR 5/2), common medium distinct yellowish brown (10YR 5/6), and few fine prominent yellowish red (5YR 5/8) mottles; weak medium subangular blocky structure; friable; few fine black stains; slightly acid; gradual smooth boundary.

Bw2—10 to 24 inches; yellowish brown (10YR 5/4) silt loam; many medium distinct light brownish gray (10YR 6/2), common medium distinct yellowish brown (10YR 5/6), and common medium prominent yellowish red (5YR 5/8) mottles; moderate medium

subangular blocky structure; friable; few black stains; slightly acid; gradual wavy boundary.

Bw3—24 to 46 inches; grayish brown (2.5Y 5/2) silt loam; common medium prominent yellowish brown (10YR 5/6) and common medium prominent yellowish red (5YR 5/8) mottles; moderate medium subangular blocky structure; friable; few black stains; slightly acid; gradual wavy boundary.

C—46 to 60 inches; grayish brown (2.5Y 5/2) silt loam; common medium prominent yellowish brown (10YR 5/6) and yellowish red (5YR 5/8) mottles; massive with vertical cleavage; very friable; few black stains; slightly acid.

The A horizon has value and chroma of 2 or 3. The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 4.

Dockery Series

The Dockery series consists of very deep, somewhat poorly drained soils on high flood plains along the Missouri River. These soils formed in silty alluvium. Permeability is moderate in the upper part of the profile and very slow in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Dockery silt loam, clayey substratum, rarely flooded, 700 feet south and 30 feet east of the northwest corner of sec. 35, T. 62 N., R. 39 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

C1—9 to 27 inches; stratified, brown (10YR 5/3) and black (10YR 2/1) silt loam and silty clay loam; common fine prominent yellowish red (5YR 4/6) and common coarse prominent pale brown (10YR 6/3) mottles and dark stains between bedding planes; massive with many very fine to medium bedding planes; friable; neutral; gradual smooth boundary.

C2—27 to 49 inches; stratified, dark grayish brown (10YR 4/2) and black (10YR 2/1) silt loam and silty clay loam; common medium prominent yellowish red (5YR 4/6) and few fine prominent strong brown (7.5YR 5/8) mottles and dark stains between bedding planes; massive with many medium bedding planes; friable; neutral; gradual smooth boundary.

2Abg—49 to 60 inches; black (N 2/0) silty clay; moderate medium prismatic structure parting to moderate fine subangular blocky; very firm; neutral.

The Ap horizon has value and chroma of 2 or 3. The C horizon has value of 2 to 5 and chroma of 1 to 3. The 2Abg horizon has hue of 7.5YR to 2.5Y and value and chroma of less than 2.

Dupo Series

The Dupo series consists of very deep, somewhat poorly drained soils on high flood plains along the Missouri River. These soils formed in silty and clayey alluvium. Permeability is moderate in the upper part of the profile and slow in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Dupo silt loam, rarely flooded, 2,600 feet south and 2,600 feet east of the northwest corner of sec. 20, T. 62 N., R. 39 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

C—8 to 31 inches; stratified dark grayish brown (10YR 4/2), very dark grayish brown (10YR 3/2), and black (10YR 2/1) silt loam; common medium prominent strong brown (7.5YR 5/8) and yellowish red (5YR 5/8) mottles and dark stains between bedding planes; massive with many very fine to coarse bedding planes; friable; neutral; abrupt smooth boundary.

2Ab1—31 to 35 inches; black (10YR 2/1) clay; moderate medium subangular blocky structure; very firm; neutral; clear smooth boundary.

2Ab2—35 to 60 inches; black (10YR 2/1) clay; moderate medium prismatic structure parting to strong fine angular blocky; very firm; neutral.

Depth to the clayey layer ranges from 20 to 36 inches. The Ap horizon has value of 3 or 4. The C horizon has value of 2 to 4 and chroma of 1 or 2. It dominantly is silt loam but has layers of silty clay loam in some pedons. The 2Ab horizon has value of 2 or 3 and chroma of 1 or 2. Some pedons have a 2Cg or 2Bgb horizon below the 2Ab horizon. The 2Cg or 2Bgb horizon has hue of 10YR or 2.5Y. It has higher value than the 2Ab horizon.

Exira Series

The Exira series consists of very deep, well drained, moderately permeable soils on uplands. These soils formed in thick loess. Slopes range from 9 to 14 percent.

Typical pedon of Exira silty clay loam, 9 to 14 percent slopes, eroded, 1,200 feet east and 2,300 feet south of the northwest corner of sec. 33, T. 62 N., R. 37 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; slightly acid; clear smooth boundary.

A—7 to 10 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

BA—10 to 15 inches; brown (10YR 4/3) silty clay loam; few fine distinct dark yellowish brown (10YR 5/6) and few fine faint dark grayish brown (10YR 4/2) mottles; moderate fine subangular blocky structure; firm; slightly acid; clear smooth boundary.

Bw1—15 to 23 inches; brown (10YR 4/3) silty clay loam; few fine distinct grayish brown (10YR 5/2) and common fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; slightly acid; gradual smooth boundary.

Bw2—23 to 36 inches; brown (10YR 5/3) silty clay loam; common fine faint grayish brown (10YR 5/2) and common medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; few black stains; slightly acid; gradual wavy boundary.

C—36 to 60 inches; grayish brown (2.5Y 5/2) silt loam; common medium prominent strong brown (7.5YR 5/6) and brown (10YR 5/3) mottles; massive; friable; few black stains; neutral.

The Ap and A horizons have value and chroma of 2 or 3. Some pedons have a BA horizon. The Bw horizon has value of 4 or 5 and chroma of 2 to 4. It is silt loam or silty clay loam. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 4.

Gilliam Series

The Gilliam series consists of very deep, somewhat poorly drained, moderately permeable soils on flood plains along the Missouri River. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Gilliam silt loam, rarely flooded, 1,100 feet west and 1,800 feet north of the southeast corner of sec. 30, T. 63 N., R. 40 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

A—9 to 12 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; friable; slightly effervescent; slightly alkaline; clear smooth boundary.

C1—12 to 23 inches; dark grayish brown (10YR 4/2) silt loam; few fine prominent yellowish brown (10YR 5/6) and few fine faint grayish brown (10YR 5/2) mottles; massive with few coarse bedding planes; friable; slightly effervescent; slightly alkaline; abrupt smooth boundary.

C2—23 to 43 inches; stratified, dark grayish brown (10YR 4/2) and brown (10YR 5/3) silt loam and silty clay loam; thin strata of black (10YR 2/1) silty clay; few fine distinct dark gray (N 4/0) and dark yellowish brown (10YR 4/4) mottles; massive with common coarse bedding planes; firm; slightly effervescent; slightly alkaline; abrupt smooth boundary.

C3—43 to 60 inches; layers of grayish brown (10YR 5/2) and dark grayish brown (10YR 4/2) silt loam; few fine prominent yellowish brown (10YR 5/6) and few fine faint pale brown (10YR 6/3) mottles; massive with many fine to coarse bedding planes; friable; strongly effervescent; moderately alkaline.

The Ap and A horizons have value of 2 or 3 and chroma of 1 to 3. The C horizon is mostly stratified loam, silt loam, or silty clay loam, but in some pedons it has thin layers of coarser and finer textured material. It has hue of 10YR or 2.5Y, value of 2 to 5, and chroma of 1 to 3. It has mottles with hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 6.

Grable Series

The Grable series consists of very deep, somewhat excessively drained and well drained soils on low flood plains along the Missouri River. These soils formed in silty and sandy alluvium. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Grable very fine sandy loam, rarely flooded, 2,600 feet north and 1,200 feet west of the southeast corner of sec. 11, T. 60 N., R. 39 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) very fine sandy loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; slightly effervescent; slightly alkaline; clear smooth boundary.

C1—8 to 21 inches; grayish brown (10YR 5/2) very fine sandy loam; few fine prominent yellowish brown (10YR 5/6) mottles; massive with many medium bedding planes; very friable; strongly effervescent; slightly alkaline; gradual smooth boundary.

C2—21 to 30 inches; stratified dark grayish brown (2.5Y 4/2), grayish brown (2.5Y 5/2), and brown (10YR 5/3) silt loam; few fine prominent yellowish brown (10YR 5/6) mottles; massive with common fine

bedding planes; very friable; strongly effervescent; slightly alkaline; abrupt smooth boundary.

2C3—30 to 60 inches; dark grayish brown (10YR 4/2) fine sand; few fine prominent strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) mottles; single grain; loose; strongly effervescent; slightly alkaline.

The Ap horizon has chroma of 2 or 3. The C and 2C horizons have hue of 2.5Y or 10YR, value of 3 to 5, and chroma of 2 or 3. Thin strata of coarser or finer textured material are in the C horizon in some pedons. The 2C horizon is fine sand or loamy fine sand. Some pedons have a loamy substratum below the 2C horizon. This layer has colors similar to those of the C and 2C horizons. It has textures ranging from fine sand to silt loam.

Hamburg Series

The Hamburg series consists of very deep, somewhat excessively drained, moderately permeable soils on the upland river hills bordering the Missouri River flood plain. These soils formed in calcareous loess. Slopes range from 45 to 90 percent.

Typical pedon of Hamburg silt loam, in an area of Timula-Hamburg silt loams, 14 to 90 percent slopes, 1,200 feet south and 750 feet west of the northeast corner of sec. 30, T. 61 N., R. 38 W.

A—0 to 4 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine and very fine granular structure; very friable; slightly effervescent; neutral; clear smooth boundary.

AC—4 to 14 inches; brown (10YR 4/3) silt loam; weak very fine granular structure; very friable; strongly effervescent; slightly alkaline; diffuse smooth boundary.

C—14 to 25 inches; brown (10YR 5/3) silt loam; appears massive but has some vertical cleavage; very friable; strongly effervescent; slightly alkaline; diffuse smooth boundary.

Ck—25 to 60 inches; brown (10YR 5/3) silt loam; few fine faint yellowish brown (10YR 5/4) and light brownish gray (10YR 5/6) mottles; appears massive but has some vertical cleavage; very friable; few small calcium carbonate nodules; strongly effervescent; slightly alkaline.

The content of clay in the control section averages less than 12 percent. The A horizon has value of 3 or 4 and chroma of 2 or 3. The AC and C horizons have value of 4 to 6 and chroma of 3 or 4. They are silt loam, silt, or very fine sandy loam.

Haynie Series

The Haynie series consists of very deep, well drained, moderately permeable soils on flood plains along the Missouri River. These soils formed in calcareous alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Haynie silt loam, rarely flooded, 2,000 feet west and 1,250 feet south of the northeast corner of sec. 23, T. 63 N., R. 41 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; weak fine granular structure; friable; slightly effervescent; moderately alkaline; clear smooth boundary.

C1—8 to 17 inches; layers of brown (10YR 4/3) and very dark brown (10YR 2/2) silt loam; few fine prominent strong brown (7.5YR 5/6) and few fine faint pale brown (10YR 6/3) mottles; massive with common fine bedding planes; very friable; strongly effervescent; moderately alkaline; abrupt smooth boundary.

C2—17 to 40 inches; stratified, brown (10YR 4/3) silt loam; fine bedding planes of very dark brown (10YR 2/2) silt loam; common medium prominent strong brown (7.5YR 5/6) and common medium distinct pale brown (10YR 6/3) mottles; massive with many fine and medium bedding planes; very friable; strongly effervescent; moderately alkaline; abrupt smooth boundary.

C3—40 to 60 inches; layers of brown (10YR 4/3) and dark brown (10YR 3/3) silt loam; few fine prominent strong brown (7.5YR 5/6) mottles; massive with many medium and coarse bedding planes; friable; strongly effervescent; moderately alkaline.

The C horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 to 3. It is silt loam or very fine sandy loam.

Judson Series

The Judson series consists of very deep, well drained, moderately permeable soils on foot slopes adjacent to flood plains. These soils formed in silty slope alluvium from uplands. Slopes range from 1 to 7 percent.

Typical pedon of Judson silt loam, in an area of Kenridge-Judson complex, 1 to 7 percent slopes, 2,640 feet north and 150 feet east of the southwest corner of sec. 3, T. 62 N., R. 39 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

A—8 to 24 inches; very dark grayish brown (10YR 3/2)

silt loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw1—24 to 41 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; firm; slightly acid; clear smooth boundary.

Bw2—41 to 60 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; neutral.

The content of clay in the 10- to 40-inch control section averages 27 to 35 percent. The Ap and A horizons have value of 2 or 3 and chroma of 1 to 3. The Bw horizon has value and chroma of 3 or 4. It is silt loam or silty clay loam.

Kenmoor Series

The Kenmoor series consists of very deep, moderately well drained soils on low flood plains along the Missouri River. These soils formed in mixed alluvium. Permeability is rapid in the upper part of the profile and slow in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Kenmoor fine sandy loam, in an area of Kenmoor-Grable complex, rarely flooded, 2,500 feet north and 1,300 feet east of the southwest corner of sec. 11, T. 61 N., R. 40 W.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) fine sandy loam, brown (10YR 5/3) dry; weak fine granular structure; very friable; slightly effervescent; slightly alkaline; clear smooth boundary.

C—10 to 27 inches; stratified brown (10YR 5/3) and pale brown (10YR 6/3) loamy fine sand; few medium prominent strong brown (7.5YR 5/8) mottles; single grain; loose; slightly effervescent; slightly alkaline; abrupt smooth boundary.

2Ab—27 to 35 inches; very dark grayish brown (2.5Y 3/2) silty clay; few fine prominent strong brown (7.5YR 5/8) and yellowish red (5YR 5/8) mottles; strong fine angular blocky structure; firm; slightly effervescent; slightly alkaline; clear smooth boundary.

2Bb—35 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay; few fine prominent strong brown (7.5YR 5/8) and yellowish red (5YR 5/8) mottles; moderate medium prismatic structure parting to strong fine angular blocky; firm; slightly effervescent; slightly alkaline.

Depth to the clayey layer typically ranges from 20 to 35 inches. The Ap horizon has value of 3 to 5 and chroma of 2 or 3. The C horizon has value of 4 to 6 and chroma of 2 or 3. It is loamy fine sand or fine sand. The 2Ab and 2Bb horizons have hue of 10YR to 5Y, value of 2 to 5, and chroma of 1 or 2. They are silty clay loam, silty clay, or clay averaging more than 35 percent clay.

Kenridge Series

The Kenridge series consists of very deep, moderately well drained, moderately slowly permeable soils on narrow flood plains along secondary streams. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Kenridge silty clay loam, in an area of Kenridge-Judson complex, 1 to 7 percent slopes, 1,760 feet east and 150 feet south of the northwest corner of sec. 35, T. 63 N., R. 39 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; moderate medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

A1—8 to 17 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine angular blocky structure; friable; slightly acid; clear smooth boundary.

A2—17 to 45 inches; black (N 2/0) silty clay loam, dark gray (N 4/0) dry; moderate medium prismatic structure parting to moderate fine angular blocky; firm; slightly acid; gradual smooth boundary.

Bw—45 to 60 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; neutral.

The mollic epipedon is 36 or more inches thick. The Ap and A horizons have hue of 10YR or are neutral in hue. They have value of 2 or 3 and chroma of 0 to 2. The Bw horizon has value of 2 or 3 and chroma of 1 or 2.

Knox Series

The Knox series consists of very deep, well drained, moderately permeable soils on uplands that border the flood plain along the Missouri River and its tributaries. These soils formed in thick loess. Slopes range from 5 to 35 percent.

Typical pedon of Knox silty clay loam, 5 to 9 percent slopes, eroded, 600 feet east and 600 north of the southwest corner of sec. 26, T. 60 N., R. 37 W.

A—0 to 8 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate fine granular

structure; friable; moderately acid; clear smooth boundary.

Bt1—8 to 15 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate medium subangular blocky structure; firm; few faint clay films on faces of peds; few fine black stains on faces of peds; slightly acid; gradual smooth boundary.

Bt2—15 to 43 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate medium subangular blocky structure; firm; few faint clay films on faces of peds; few fine prominent black stains on faces of peds; slightly acid; gradual smooth boundary.

BC—43 to 47 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; friable; few fine prominent dark stains on faces of peds; slightly acid; gradual wavy boundary.

C—47 to 60 inches; brown (10YR 5/3) silt loam; common fine faint light brownish gray (10YR 6/2) and common medium prominent strong brown (7.5YR 5/8) mottles; massive with vertical cleavage; friable; common fine prominent black stains on faces of peds; neutral.

The Ap or A horizon has value of 2 to 4 and chroma of 2 or 3. It is silt loam or silty clay loam. The Bt horizon has value of 4 or 5 and chroma of 3 to 6. It is silt loam or silty clay loam. The BC and C horizons have hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 6.

Lamoni Series

The Lamoni series consists of very deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in a thin mantle of loess and in the underlying paleosol, which formed in glacial till. Slopes range from 5 to 9 percent.

The Lamoni soils in this survey area have a thinner dark surface layer than is defined as the range for the series. This difference, however, does not significantly affect the use and management of the soils. The soils are classified as fine, montmorillonitic, mesic Vertic Epiaqualfs.

Typical pedon of Lamoni silty clay loam, 5 to 9 percent slopes, eroded, 2,400 feet east and 1,000 feet south of the northwest corner of sec. 29, T. 63 N., R. 37 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; firm; neutral; clear smooth boundary.

2Bt1—8 to 13 inches; dark grayish brown (10YR 4/2) clay loam; few fine prominent strong brown (7.5YR 4/6) mottles; moderate medium subangular blocky structure; firm; common faint clay films on faces of peds; about 5 percent pebbles; slightly acid; gradual smooth boundary.

2Bt2—13 to 23 inches; dark brown (10YR 4/3) clay loam; common medium distinct dark brown (7.5YR 4/4), common medium prominent strong brown (7.5YR 4/6), and common medium faint grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; few faint clay films on faces of peds; about 5 percent pebbles; moderately acid; gradual smooth boundary.

2Bt3—23 to 39 inches; grayish brown (10YR 5/2) clay loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; firm; few faint clay films on faces of peds; about 5 percent pebbles; slightly acid; gradual wavy boundary.

2Bt4—39 to 48 inches; gray (10YR 6/1) clay loam; few fine prominent strong brown (7.5YR 5/6) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; few faint clay films on faces of peds; about 5 percent pebbles; slightly acid; clear smooth boundary.

2C—48 to 60 inches; gray (10YR 6/1) and yellowish brown (10YR 5/6) clay loam; common medium prominent white (10YR 8/1) mottles; massive; firm; about 5 percent pebbles; neutral.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. The 2Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 6. It is clay loam or clay.

Leta Series

The Leta series consists of very deep, somewhat poorly drained soils on low flood plains along the Missouri River. These soils formed in calcareous, clayey and loamy alluvium. Permeability generally is slow in the upper part of the profile and moderate in the lower part, but in some pedons permeability is rapid below a depth of 50 inches. Slopes range from 0 to 2 percent.

Typical pedon of Leta silty clay, rarely flooded, 1,000 feet north and 1,000 feet west of the southeast corner of sec. 6, T. 62 N., R. 40 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; strong fine angular blocky structure; firm; slightly effervescent; slightly alkaline; clear smooth boundary.

A—8 to 19 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; few fine prominent yellowish red (5YR 4/8) mottles; moderate medium prismatic structure parting to strong fine angular blocky; firm; slightly alkaline; gradual smooth boundary.

Bw—19 to 28 inches; dark grayish brown (10YR 4/2) silty clay; few fine prominent yellowish red (5YR 4/8) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; very firm; slightly effervescent; moderately alkaline; abrupt smooth boundary.

2C—28 to 60 inches; stratified, dark grayish brown (10YR 4/2) very fine sandy loam; thin strata of black (10YR 2/1) silt loam; many fine prominent strong brown (7.5YR 5/8) mottles; massive with many fine and medium bedding planes; very friable; strongly effervescent; moderately alkaline.

Depth to the 2C horizon ranges from 20 to 35 inches. The Ap and A horizons have value of 2 or 3 and chroma of 1 or 2. They are silt loam or silty clay. The Bw horizon has hue of 2.5Y or 10YR, value of 3 to 5, and chroma of 1 or 2. It is silty clay loam or silty clay. The 2C horizon typically is stratified silt loam or very fine sandy loam but has thin strata of sand, loamy fine sand, and sandy loam in some pedons. It has value of 4 to 6 and chroma of 2 to 4. The substratum of some pedons is loamy fine sand or fine sand.

Luton Series

The Luton series consists of very deep, poorly drained, very slowly permeable soils on flood plains along the Missouri River. These soils formed in clayey alluvium. Slopes range from 0 to 2 percent.

The Luton soils in this survey area have more clay in the control section than is defined as the range for the series. This difference, however does not significantly affect the use and management of the soils. The soils are classified as very fine, montmorillonitic, mesic Vertic Haplaquolls.

Typical pedon of Luton clay, rarely flooded, 1,500 feet south and 30 feet west of the northeast corner of sec. 31, T. 58 N., R. 37 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; very firm; slightly alkaline; clear smooth boundary.

A1—7 to 20 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; strong fine angular blocky structure; very firm; few pressure faces; neutral; gradual smooth boundary.

A2—20 to 38 inches; very dark gray (10YR 3/1) clay, gray (10YR 5/1) dry; few fine prominent strong brown (7.5YR 5/8) mottles; strong fine angular blocky structure; very firm; few pressure faces; neutral; gradual smooth boundary.

Bg1—38 to 42 inches; dark gray (5Y 4/1) silty clay; common fine prominent strong brown (7.5YR 5/6) mottles; strong fine angular blocky structure; very firm; few pressure faces; neutral; gradual smooth boundary.

Bg2—42 to 60 inches; dark gray (5Y 4/1) silty clay; common fine prominent strong brown (7.5YR 5/6) and many fine distinct dark yellowish brown (10YR 4/4) mottles; strong fine angular blocky structure; very firm; few pressure faces; slightly alkaline.

The Ap and A horizons have hue of 10YR or are neutral in hue. They have value of 2 or 3 and chroma of 0 or 1. The Bg horizon has value of 4 or 5 and chroma of 1 or 2. It is silty clay or clay. Some pedons have a thin, dark buried A horizon within the Bg horizon.

Marshall Series

The Marshall series consists of very deep, well drained, moderately permeable soils on ridges in the uplands. These soils formed in thick loess. Slopes range from 2 to 14 percent.

Typical pedon of Marshall silty clay loam, 2 to 5 percent slopes, 700 feet east and 1,300 feet north of the southwest corner of sec. 16, T. 62 N., R. 38 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; friable; neutral; clear smooth boundary.

A—9 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; friable; very dark brown (10YR 2/2) coatings on faces of peds; neutral; clear smooth boundary.

AB—14 to 19 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; firm; neutral; clear smooth boundary.

Bw1—19 to 25 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine subangular blocky structure; firm; very dark grayish brown (10YR 3/2) coatings on faces of peds; slightly acid; gradual smooth boundary.

Bw2—25 to 40 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate medium prismatic structure parting to moderate fine subangular blocky; firm; dark brown (10YR 3/3) coatings on faces of peds; neutral; gradual wavy boundary.

BC—40 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam; common medium distinct grayish brown (10YR 5/2) and common fine distinct strong brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak fine subangular blocky; friable; neutral.

The 10- to 40-inch control section has a coarse silt to

fine silt ratio of less than 1.45. The Ap and A horizons have value of 2 or 3 and chroma of 1 or 2. The Bw horizon has value of 3 to 5 and chroma of 3 or 4. The BC and C horizons are silty clay loam or silt loam. They have hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 6.

Marshall silty clay loam, 5 to 9 percent slopes, eroded, and Marshall silty clay loam, 9 to 14 percent slopes, eroded, have a thinner dark surface layer than is defined as the range for the series. This difference, however, does not significantly affect the use and management of the soils. The soils are classified as fine-silty, mixed, mesic Dystric Eutrochrepts.

Modale Series

The Modale series consists of very deep, somewhat poorly drained soils on low flood plains along the Missouri River. These soils formed in silty and clayey alluvium. Permeability is moderate in the upper part of the profile and slow in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Modale silt loam, rarely flooded, 200 feet south and 30 feet west of the northeast corner of sec. 7, T. 60 N., R. 39 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; neutral; clear smooth boundary.

C1—9 to 18 inches; stratified, brown (10YR 4/3) and dark grayish brown (10YR 4/2) silt loam; few fine and medium prominent strong brown (7.5YR 5/8) and few fine faint pale brown (10YR 6/3) mottles; massive with many very fine bedding planes; friable; few very fine calcium carbonate concretions; strongly effervescent; slightly alkaline; gradual smooth boundary.

C2—18 to 30 inches; stratified, brown (10YR 4/3) and dark grayish brown (10YR 4/2) silt loam; common medium prominent yellowish red (5YR 5/8), common medium distinct grayish brown (10YR 5/2), and few fine prominent yellowish brown (10YR 5/6) mottles and dark stains; massive with many very fine bedding planes; friable; many fine calcium carbonate concretions; strongly effervescent; slightly alkaline; abrupt smooth boundary.

2Cg1—30 to 50 inches; dark grayish brown (2.5Y 4/2) silty clay; many fine and medium prominent yellowish red (5YR 5/8) and common medium distinct grayish brown (10YR 5/2) mottles and dark stains; moderate medium subangular blocky structure; firm; many fine calcium carbonate concretions; strongly effervescent; slightly alkaline; gradual diffuse boundary.

2Cg2—50 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay; common medium prominent yellowish red (5YR 5/8) and strong brown (7.5YR 5/8) mottles and dark stains; moderate medium subangular blocky structure; firm; many fine and coarse calcium carbonate concretions; strongly effervescent; slightly alkaline.

Depth to the clayey layer ranges from 18 to 36 inches. The C horizon has value of 4 or 5 and chroma of 2 or 3. It dominantly is silt loam or very fine sandy loam, but it has strata of coarser and finer textured material in some pedons. The 2C horizon has hue of 10YR to 5Y, value of 3 to 5, and chroma of 1 to 3. It is silty clay or clay.

Monona Series

The Monona series consists of very deep, well drained, moderately permeable soils on uplands. These soils formed in thick loess. Slopes range from 2 to 14 percent.

Typical pedon of Monona silt loam, 2 to 5 percent slopes, 1,600 feet north and 200 feet east of the southwest corner of sec. 5, T. 59 N., R. 37 W.

Ap—0 to 6 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; neutral; clear smooth boundary.

A—6 to 14 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; friable; neutral; gradual smooth boundary.

AB—14 to 21 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

Bw1—21 to 30 inches; dark yellowish brown (10YR 4/4) silt loam; moderate fine subangular blocky structure; friable; dark brown (10YR 3/3) coatings on faces of peds; moderately acid; gradual smooth boundary.

Bw2—30 to 46 inches; dark yellowish brown (10YR 4/4) silt loam; few fine distinct yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; friable; slightly acid; gradual smooth boundary.

C1—46 to 60 inches; yellowish brown (10YR 5/4) silt loam; common fine prominent strong brown (7.5YR 5/6) and many fine distinct grayish brown (10YR 5/2) mottles; appears massive but has some vertical cleavage; friable; slightly acid.

The subsoil has 18 to 27 percent clay in all horizons.

The 10- to 40-inch control section has a ratio of coarse silt to fine silt greater than 1.45. The Ap and A horizons have value of 2 or 3 and chroma of 1 to 3. The Bw horizon has value of 4 or 5 and chroma of 3 or 4.

Monona silt loam, 5 to 9 percent slopes, eroded, and Monona silt loam, 9 to 14 percent slopes, eroded, have a thinner dark surface layer than is defined as the range for the series. This difference, however, does not significantly affect the use and management of the soils. The soils are classified as fine-silty, mixed, mesic Dystric Eutrochrepts.

Motark Series

The Motark series consists of very deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Motark silt loam, rarely flooded, 2,600 feet south and 1,800 feet west of the northeast corner of sec. 32, T. 62 N., R. 39 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

C—9 to 15 inches; layers of dark grayish brown (10YR 4/2) and brown (10YR 4/3) silt loam; few fine prominent strong brown (7.5YR 5/6) masses of iron accumulation on faces of bedding planes; massive with many very fine bedding planes; very friable; neutral; gradual smooth boundary.

Cg—15 to 60 inches; layers of dark grayish brown (10YR 4/2), grayish brown (10YR 5/2), and brown (10YR 5/3) silt loam; common very thin and thin horizontal strata of darker material; common fine and medium prominent yellowish red (5YR 5/8) and strong brown (7.5YR 5/8) masses of iron accumulation between bedding planes and on soil matrix; massive with many fine to coarse bedding planes; very friable; common black stains between bedding planes; neutral.

The Ap horizon has chroma of 2 or 3. The C horizon has value of 4 or 5 and chroma of 2 or 3. Pedons that have thin strata of very dark brown (10YR 2/2), very dark grayish brown (10YR 3/2), or dark brown (10YR 3/3) are within the range of the series if they are in a sequence of stratified sediments and not a surface layer of a buried soil. Stains and mottles are mostly on the faces of bedding planes and are few or common throughout the C horizon. The C horizon typically is silt loam with less than 18 percent clay, but in some pedons it has thin strata of silty clay loam.

Napier Series

The Napier series consists of very deep, well drained, moderately permeable soils on foot slopes and alluvial fans. These soils formed in silty slope alluvium from the uplands. Slopes range from 1 to 7 percent.

Typical pedon of Napier silt loam, in an area of Napier-Gullied land complex, 1 to 7 percent slopes, 1,600 feet west and 900 feet south of the northeast corner of sec. 20, T. 61 N., R. 38 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

A—8 to 16 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; neutral; gradual smooth boundary.

AB—16 to 24 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw1—24 to 43 inches; dark brown (10YR 4/3) silt loam; moderate medium subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw2—43 to 60 inches; dark brown (10YR 4/3) silt loam; moderate medium subangular blocky structure; firm; neutral.

The 10- to 40-inch control section typically is silt loam throughout and averages 20 to 27 percent clay. The Ap and A horizons have value of 2 or 3 and chroma of 1 or 2. The Bw horizon has value of 3 or 4.

Nodaway Series

The Nodaway series consists of very deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Nodaway silt loam, in an area of Nodaway-Judson silt loams, 1 to 7 percent slopes, 1,400 feet east and 100 feet north of the southwest corner of sec. 6, T. 62 N., R. 38 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; neutral; clear smooth boundary.

C1—8 to 53 inches; stratified, dark grayish brown (10YR 4/2) silt loam; thin strata of black (10YR 2/1) silty clay loam; common fine to coarse prominent strong brown (7.5YR 5/8) and yellowish red (5YR 5/8) mottles between bedding planes; massive with

many fine to coarse bedding planes; friable; neutral; gradual smooth boundary.

C2—53 to 60 inches; stratified, very dark brown (10YR 2/2) and dark brown (10YR 4/3) silty clay loam; few fine prominent strong brown (7.5YR 5/8) mottles; massive with few coarse bedding planes; firm; neutral.

The Ap horizon has chroma of 1 or 2. The C horizon has value of 3 to 5 and chroma of 1 to 3. Some pedons have a dark buried A horizon.

Sarpy Series

The Sarpy series consists of very deep, excessively drained, rapidly permeable soils on low flood plains along the Missouri River. These soils formed in calcareous, sandy alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Sarpy loamy fine sand, rarely flooded, 2,650 feet south and 50 feet east of the northwest corner of sec. 31, T. 63 N., R. 40 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; slightly alkaline; clear smooth boundary.

C1—7 to 24 inches; dark grayish brown (2.5Y 4/2) fine sand; single grain with many fine bedding planes; loose; slightly effervescent; slightly alkaline; clear smooth boundary.

C2—24 to 60 inches; light brownish gray (10YR 6/2) fine sand; single grain with many fine bedding planes; loose; slightly effervescent; slightly alkaline.

The Ap horizon has value of 3 or 4 and chroma of 2 or 3. It is loamy fine sand or fine sand. The C horizon has value of 4 to 6 and chroma of 2 or 3. It is sand, loamy sand, or loamy fine sand.

Shelby Series

The Shelby series consists of very deep, moderately well drained, moderately slowly permeable soils on uplands. These soils formed in glacial till. Slopes range from 9 to 14 percent.

The Shelby soils in this survey area have a thinner dark surface layer than is defined as the range for the series. This difference, however, does not significantly affect the use and management of the soils. The soils are classified as fine-loamy, mixed, mesic Mollic Hapludalfs.

Typical pedon of Shelby clay loam, 9 to 14 percent slopes, eroded, 2,600 feet west and 500 feet north of the southeast corner of sec. 25, T. 63 N., R. 38 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; firm; about 10 percent pebbles and cobbles; slightly alkaline; clear smooth boundary.

Bt1—8 to 14 inches; dark brown (10YR 4/3) clay loam; moderate fine subangular blocky structure; firm; few faint clay films on faces of peds; about 10 percent pebbles and cobbles; neutral; clear smooth boundary.

Bt2—14 to 20 inches; dark brown (10YR 4/3) clay loam; common fine prominent strong brown (7.5YR 5/6) and few fine faint light brownish gray (10YR 6/2) mottles; moderate medium subangular blocky structure; firm; few faint clay films on faces of peds; few dark stains on faces of peds; about 10 percent pebbles and cobbles; neutral; gradual smooth boundary.

Bt3—20 to 29 inches; yellowish brown (10YR 5/4) clay loam; common medium prominent strong brown (7.5YR 5/6) and many medium distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; common faint clay films on faces of peds; common dark stains on faces of peds; about 10 percent pebbles and cobbles; slightly acid; gradual smooth boundary.

Bt4—29 to 39 inches; yellowish brown (10YR 5/4) clay loam; many medium distinct light brownish gray (10YR 6/2) and common medium prominent strong brown (7.5YR 5/8) mottles; moderate medium subangular blocky structure; firm; common faint clay films on faces of peds; common dark stains on faces of peds; about 10 percent pebbles and cobbles; slightly acid; gradual wavy boundary.

C1—39 to 50 inches; light brownish gray (10YR 6/2) clay loam; many medium prominent yellowish brown (10YR 5/6) mottles; massive with vertical cleavage; firm; many dark stains on faces of peds; about 10 percent glacial pebbles and cobbles; neutral; gradual wavy boundary.

C2—50 to 60 inches; mottled light brownish gray (10YR 6/2) and yellowish brown (10YR 5/6) clay loam; massive; firm; many dark stains on faces of peds; about 10 percent pebbles and cobbles; neutral.

The Ap horizon has value of 2 or 3 and chroma of 1 to 3. The Bt horizon has value of 4 or 5 and chroma of 3 to 6. It is clay loam or clay and contains less than 35 percent clay.

Timula Series

The Timula series consists of very deep, well drained, moderately permeable soils on the upland river hills bordering the flood plains along the Missouri River and its tributaries. These soils formed in thick loess.

Slopes range from 2 to 45 percent.

Typical pedon of Timula silt loam, in an area of Timula-Hamburg silt loams, 14 to 90 percent slopes, 1,400 feet south and 400 feet east of the northwest corner of sec. 21, T. 61 N., R. 38 W.

A1—0 to 3 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak medium granular structure; very friable; slightly alkaline; clear smooth boundary.

A2—3 to 7 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak medium granular structure; very friable; slightly alkaline; clear smooth boundary.

Bw—7 to 20 inches; dark brown (10YR 4/3) silt loam; weak fine subangular blocky structure; friable; slightly alkaline; clear smooth boundary.

C—20 to 33 inches; brown (10YR 5/3) silt loam; massive with vertical cleavage; very friable; strongly effervescent; slightly alkaline; gradual wavy boundary.

Ck—33 to 60 inches; brown (10YR 5/3) silt loam; common vertical yellowish brown (10YR 5/6) streaks; massive with vertical cleavage; very friable; few calcium carbonate concretions; violently effervescent; moderately alkaline.

The depth to carbonates typically ranges from 18 to 36 inches. The A horizon has value of 3 or 4 and chroma of 2 or 3. The Bw horizon has value of 4 or 5 and chroma of 3 to 6. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 4. Some pedons have relict mottles in the C horizon.

Vanmeter Series

The Vanmeter series consists of moderately deep, moderately well drained, very slowly permeable soils on the upland river hills bordering the flood plains along the Missouri River and its tributaries. These soils formed in colluvium weathered from calcareous shale and limestone. Slopes range from 14 to 45 percent.

Typical pedon of Vanmeter flaggy silt loam, 14 to 45 percent slopes, 400 feet east and 200 feet south of the northwest corner of sec. 13, T. 59 N., R. 37 W.

A—0 to 7 inches; very dark grayish brown (10YR 3/2) flaggy silt loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; friable; about 25 percent flagstones of limestone; neutral; clear smooth boundary.

Bw1—7 to 10 inches; yellowish brown (10YR 5/4) silty clay loam; moderate fine subangular blocky structure; firm; about 15 percent flagstones of limestone; strongly effervescent; slightly alkaline; clear smooth boundary.

2Bw2—10 to 18 inches; light olive brown (2.5Y 5/4) silty clay; moderate fine subangular blocky structure; firm; about 5 percent flagstones of limestone; slightly effervescent; slightly alkaline; gradual wavy boundary.

2Bw3—18 to 22 inches; light olive brown (2.5Y 5/4) silty clay; moderate fine subangular blocky structure; strongly effervescent; slightly alkaline; abrupt smooth boundary.

2Cr—22 to 60 inches; soft clay shale and siltstone.

Paralithic contact is at a depth of 20 to 40 inches. The content of rock fragments ranges from 5 to 30 percent in the solum. The A horizon has value of 3 or 4 The Bw horizon has hue of 2.5Y to 5YR, value of 4 or 5, and chroma of 4 to 6.

Wabash Series

The Wabash series consists of very deep, poorly drained, very slowly permeable soils on high flood plains along the Missouri River. These soils formed in clayey alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Wabash silty clay, rarely flooded, 300 feet north and 700 feet east of the southwest corner of sec. 21, T. 63 N., R. 40 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; very firm; slightly acid; gradual smooth boundary.

A1—6 to 12 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate medium angular blocky structure; very firm; few thin coatings on vertical faces of peds that appear to be pressure faces; neutral; gradual smooth boundary.

A2—12 to 19 inches; black (N 2/0) silty clay, dark gray (N 4/0) dry; few fine prominent strong brown (7.5YR 4/6) mottles; moderate medium subangular blocky structure; very firm; few pressure faces; neutral; gradual smooth boundary.

A3—19 to 34 inches; black (N 2/0) silty clay, dark gray (N 4/0) dry; few fine prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; very firm; few pressure faces; neutral; gradual smooth boundary.

Bg1—34 to 42 inches; very dark gray (N 3/0) clay, dark gray (N 4/0) dry; common fine prominent dark yellowish brown (10YR 4/6) and few fine prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; very firm; few pressure faces; neutral; gradual smooth boundary.

Bg2—42 to 60 inches; dark gray (N 4/0) clay, gray

(10YR 5/1) dry; common fine prominent dark yellowish brown (10YR 4/6) mottles; moderate medium subangular blocky structure; very firm; few pressure faces; neutral.

The depth to carbonates is greater than 40 inches. The Ap and A horizons have hue of 10YR or 2.5Y or are neutral in hue. They have value of 2 or 3 and chroma of 0 to 2. The Bg horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 3 to 5 and chroma of 0 to 2. It is silty clay or clay.

Zook Series

The Zook series consists of very deep, poorly drained, slowly permeable soils on flood plains. These soils formed in loamy and clayey alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Zook silty clay loam, occasionally flooded, 1,250 feet east and 2,500 feet north of the southwest corner of sec. 5, T. 66 N., R. 38 W., in Atchison County:

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; firm; moderately acid; clear smooth boundary.

A1—9 to 16 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; firm; neutral; gradual smooth boundary.

A2—16 to 24 inches; black (N 2/0) silty clay loam, dark gray (2.5Y 4/0) dry; moderate fine subangular blocky structure; firm; neutral; gradual smooth boundary.

A3—24 to 34 inches; very dark gray (10YR 3/1) silty clay, dark gray (2.5Y 4/0) dry; moderate medium subangular blocky structure; firm; neutral; gradual smooth boundary.

Bg—34 to 44 inches; very dark gray (10YR 3/1) silty clay, dark gray (N 4/0) dry; few fine prominent light brownish gray (2.5Y 6/2) mottles; moderate medium subangular blocky structure; firm; few fine distinct black stains; slightly alkaline; gradual smooth boundary.

Cg—44 to 60 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; common fine prominent light brownish gray (2.5Y 6/2) mottles; massive; firm; slightly alkaline.

The Ap and A horizons have hue of 10YR or are neutral in hue. They have value of 2 or 3 and chroma of 0 to 2. The A horizon ranges from 26 to 40 inches in thickness. It is silty clay loam or silty clay. The Bg and Cg horizons have hue of 10YR or 2.5Y and value of 2 or 3. They typically are silty clay, but the range includes silty clay loam.

Formation of the Soils

Soil is a dynamic natural body composed of a mixture of mineral and organic matter, water, and air. It is the product of soil-forming processes acting on material accumulated or deposited by geologic action. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil-forming factors were active; the plant and animal life on and in the soil; the topography, or lay of the land; and the length of time these forces have been active.

Climate and plant and animal life are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for the development of distinct horizons. Some time is always required for the differentiation of soil horizons. Generally, a long time is needed for the formation of distinct horizons.

These factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made about the effect of any one factor unless conditions are specified for the other four. Soil formation is complex, and many of the processes of soil development are still unknown.

Parent Material

Parent material is the unconsolidated mass in which soil is formed. It determines the limits of the chemical and mineralogical composition of the soil. The soils in Holt County formed in loess, or wind-deposited material; in glacial till; in colluvial and residual material derived from shale and limestone bedrock; in alluvium, or water-deposited material; or in a combination of these materials.

Loess is the predominant parent material in the uplands in Holt County. It is a wind-deposited unconsolidated mass of mainly silt-sized particles. It was derived in part from sediments deposited by rivers that were fed from the melting glaciers. In Holt County the main source of loess is from the Missouri River Valley. After the glaciers retreated and during an arid period, the wind transported the loess to cover the surrounding uplands. The thickness of the loess depends on the distance from the source and is influenced by the elevation of the surface at the point of deposition. Thickness is greater at the crest of divides and progressively decreases on both divide flanks toward and away from the source (Ruhe and others, 1967). In Holt County the loess is more than 100 feet thick on the bluffs adjacent to the Missouri River Valley and gradually thins to the east and southeast along the Nodaway River (fig. 10). With increasing distance from the source, the particle-size distribution of the loess also changes. The ratio of coarse silt to clay decreases, and the percent of clay in the subsoil generally increases (Lewis and Brown, 1982). Hamburg, Monona, and Timula soils formed in thick loess relatively close to the source, have a relatively high ratio of coarse silt to clay, and have less clay in the subsoil than soils in areas farther from the source. Contrary, Exira, Knox, and Marshall soils are farther to the east and southeast and formed in thick loess. They have a lower ratio of coarse silt to clay and generally have more clay in the subsoil.

In many areas in Holt County, secondary streams have incised the landscape and eroded the loess deposits, thus exposing the glacial till deposits underneath. Glacial till is a heterogeneous mixture of sand, silt, clay, and rock fragments ranging in size from small pebbles to boulders. The till in Holt County is known as Pre-Illinoian. The till deposit was not uniform across the county. It is thickest in the north-central part. Shelby soils formed in this slightly weathered till.

Along the steep hillslopes adjacent to the flood plains along the Missouri and Nodaway Rivers, sedimentary rocks, dominantly shales and limestones, are exposed. Vanmeter soils formed in colluvium and residuum derived from these rocks.

Alluvium is material that was transported by water and deposited on nearly level flood plains. The flood

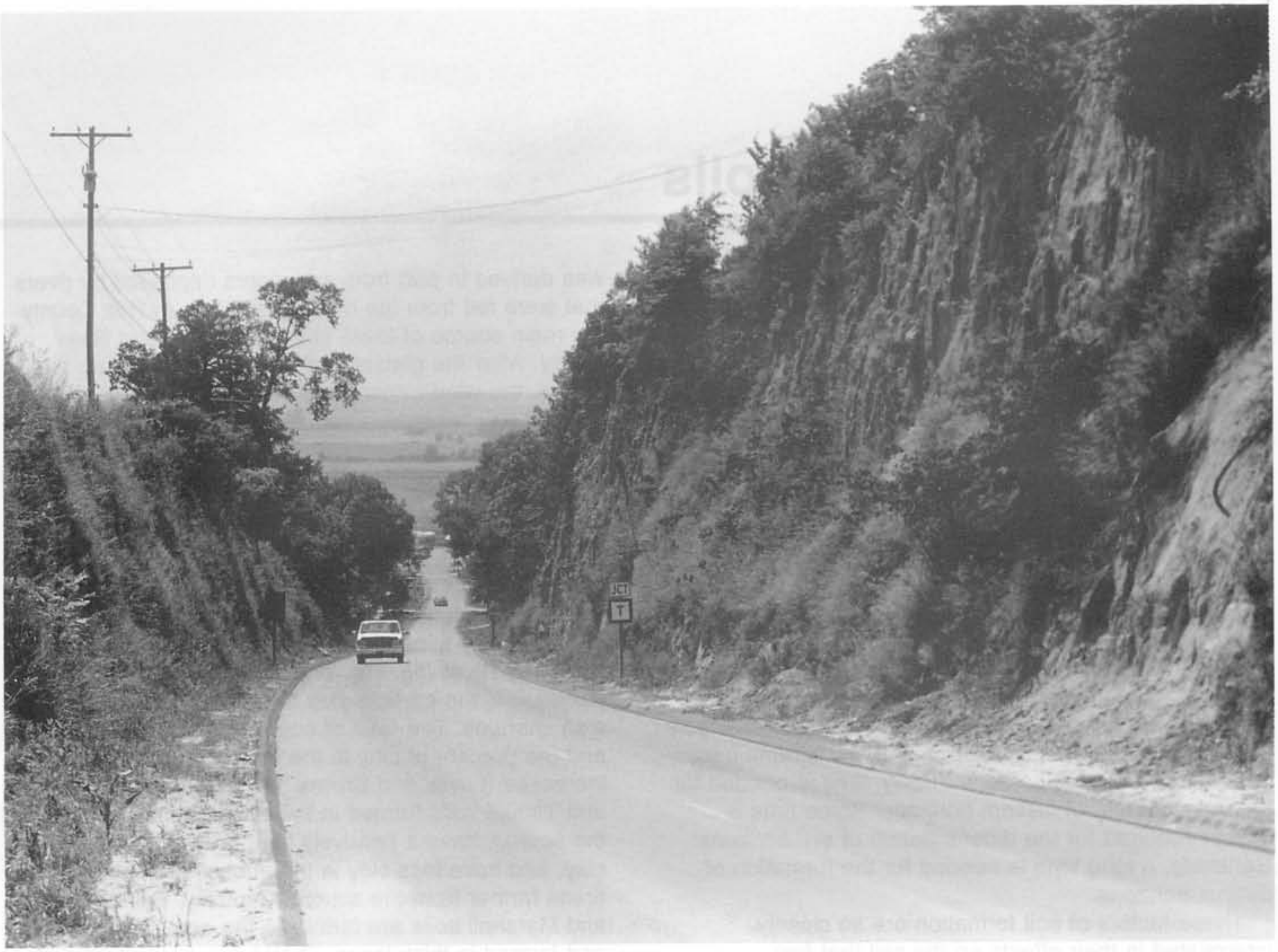

Figure 10.—Loess is the predominant parent material of the soils in Holt County. It is very stable in vertical cuts.

plains along the Missouri River and secondary streams cover more than 40 percent of Holt County. Because of its diverse origins and the varying speed of the flowing water, this material varies greatly in texture and mineralogical composition. Grable, Haynie, and Sarpy soils formed in parent material that was deposited while the water had sufficient flow and velocity to carry the coarser particles. These soils are commonly on natural levees adjacent to stream channels. Luton and Wabash soils are clayey soils that formed in material deposited in slack-water areas. They generally are farther from stream channels. Because the Missouri River has changed its course and meandered across the flood plain many times, intermediate soils have formed. Dupo and Modale soils are silt loam in the upper part and are clayey in the lower part. They originally formed in slack-water areas but were subjected to new flooding and deposition when the Missouri River changed its course. Soils that formed on natural levees and are now in slack-water areas develop profiles that have clayey textures in the upper part and loamy textures in the lower part. Leta and Blencoe soils are examples.

Climate

Climate is an important factor of soil formation. It determines the nature of the weathering that occurs, the kinds of plant and animal life, and the rate of geological and accelerated erosion.

Temperature and precipitation influence the rate of

biological, chemical, and physical processes that largely control soil development. An increase in temperature and precipitation can increase the content of organic matter and the content of clay in soils and thus affects the degree of profile development. Over a long period of time, such climatic changes can completely dominate the process of soil formation.

Changes in climate caused the glacial periods that greatly affected soil formation in Holt County. Thousands of years of cooler temperatures caused the formation of massive glaciers, which covered northern Missouri at one time. The glacial outwash deposits became the parent material for the Lamoni and Shelby soils. Later, warmer temperatures and high winds caused severe geologic erosion and the deposition of loess, which covers most of Holt County.

Holt County presently has a subhumid midcontinental climate with cold winters and hot summers. This climatic period has been drier than previous ones and has favored the growth of native prairie grasses. Soils that form under grassland vegetation have a thick, dark surface layer. Precipitation was adequate for the leaching of carbonates from many of the soils. This condition is conducive to profile development. Contrary, Exira, Marshall, Monona, and Shelby soils are examples of soils that formed under prairie vegetation.

Plants and Animals

Plants, animals, insects, bacteria, and fungi are important in the formation of soils. They affect the content of organic matter and plant nutrients, structure, and porosity of the soils.

Many forms of plant and animal life live in the soil and affect it in various ways. Plants help to stabilize soils against the erosive forces of wind and water. Dead and decaying roots provide many pores and channels for the passage of water and air through the soil. Insects and earthworms burrowing through the soil break down organic matter and minerals into simpler compounds and mix the soil, which makes it more open and porous. Bacteria and fungi are the major factors influencing the mineralization and decomposition of organic matter and nutrient recycling.

Soils that form under different types of vegetation, such as grassland or forest vegetation, have very different properties. Soils that formed under grasses have a thick, dark surface layer. Grasses produce many fine roots that decompose and add large amounts of organic matter to the soil. Because the organic matter is more uniformly distributed throughout the profile, the soil has a higher available water capacity and natural fertility levels than soils that formed under woodland. Organic matter also helps to bind soil particles into soil aggregates of granular structure, thus improving soil tilth and increasing the rate of water infiltration. The upland soils in Holt County formed during a period when the vegetation was mainly tall prairie grasses. Exira, Marshall, Monona, and Shelby soils formed under prairie grasses. Blencoe, Colo, Kenridge, Leta, Luton, and Wabash soils that are on flood plains formed under marsh vegetation. These soils also have a high content of organic matter.

In soils that formed under woodland, most of the organic matter is derived from decomposing leaves and twigs on the surface rather than from grass roots. As a result, these soils have less organic matter throughout the profile than the grassland soils. Timula and Knox soils have been affected by both grasses and trees. They have properties intermediate between those of soils that formed under grasses and those of soils that formed under trees.

Human activities have greatly influenced the soils in Holt County. Cultivated crops have replaced most of the native prairie grasses. Intensive cultivation has resulted in accelerated erosion on the sloping upland soils. Much of the original dark surface layer has been lost, and the soils are less productive. Levees and drainage ditches have reduced the amount of flooding and lowered the water table. Thousands of acres of wet bottom land have been converted to productive farmland. In some areas, land grading has also changed many soils by altering the original profiles.

Topography

Topography, or lay of the land, affects soil formation through its effect on drainage, runoff, the infiltration rate, and accelerated erosion. The amount of water entering and passing through the soil depends on the slope, permeability, and the amount and intensity of rainfall. Because runoff is rapid on steep soils, very little water passes through the soil material and soil formation is slow. Steep slopes are partially responsible for weak profile development in the Hamburg and Timula soils. Also, the depth to soluble calcium carbonates in the Timula soils is generally greater in the less sloping areas because of more effective leaching of the soil material. On sloping land under intensive cultivation, accelerated erosion can remove much of the original soil profile.

Runoff is slow on gently sloping and nearly level soils, and much of the water passes through the soil material, allowing for the formation of more distinct horizons. Also, under natural conditions the surface horizon is generally thicker in the less sloping areas because of natural erosion.

Soils in low, nearly level positions have slow or very

slow runoff rates and commonly have a seasonal high water table within the soil profile. Drainage can be restricted, and the soil profile develops slowly. Soil colors are grayish or mottled by the wetting and drying of the soil. Luton and Wabash soils are examples of wet soils on flood plains. These soils have a seasonal high water table.

Soils on south-facing slopes receive the sun's rays more directly and are more droughty than soils on north-facing slopes. Droughtiness influences soil formation through its effect on the kind of vegetation, erosion, and freezing and thawing.

Time

The degree of profile development is dependent on the length of time that the parent material has been in place and subject to the soil-forming processes. Young soils show little evidence of profile development, or horizon differentiation. Older soils show the effects of the downward movement of clay and leaching and have distinct horizons.

The youngest soils in Holt County are those that formed in alluvium. These soils are subject to flooding and receive new sediments with every flood. A general separation can be made about the soils on the Missouri River flood plain. A distinction can be made between the high flood plain, or the meander belt, and the low flood plain, which is the channel belt of the Missouri River. The alluvial Blencoe, Luton, and Wabash soils on the high flood plain generally have a thicker surface layer and are leached of carbonates in the upper part of the profile. Grable, Haynie, Leta, and Sarpy soils on low flood plains have a thinner surface layer and have carbonates at or near the surface.

The soils on uplands are older than the soils on flood plains. Vanmeter soils formed in colluvium and in material weathered from interbedded limestone and shale. This material is very old, but because these soils are in such steep areas they show only limited profile development.

Lamoni and Shelby soils formed in glacial material that was deposited over the limestone and shale. Lamoni soils formed on an old, exposed till surface more than 150,000 years ago. Shelby soils formed on recently dissected slopes, probably 11,000 to 14,000 years ago.

The most recent parent material that covers the uplands is Peoria loess from the Wisconsin age that was deposited about 14,000 to 16,000 years ago (Ruhe and others, 1967). Contrary, Hamburg, Knox, Marshall, Monona, and Timula soils formed in this material. Hamburg and Timula soils have weakly expressed profiles because the natural process of geologic erosion continually removes material from these steep areas.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedding system. A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Broad-base terrace. A ridge-type terrace built to control erosion by diverting runoff along the contour at a nonscouring velocity. The terrace is 10 to 20 inches high and 15 to 30 feet wide and has gently sloping sides, a rounded crown, and a dish-shaped channel along the upper side. It may be nearly level or have a grade toward one or both ends.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Catsteps. Very small, irregular terraces on steep hillsides, especially in pasture, formed by the trampling of cattle or the slippage of saturated soil.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural

class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles 2 millimeters to 38 centimeters (15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Colluvium. Soil material or rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosion. Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for

significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, or clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 38 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers

especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of the material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Head slope. The concave surface at the head of a drainageway where the flow of water converges downward toward the center and contour lines form concave curves.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and

deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Interfluve. The relatively undissected upland or ridge between two adjacent valleys containing streams flowing in the same general direction or any elevated area between two drainageways that shed water to them.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are:

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by the wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,*

more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Narrow-base terrace. A terrace no more than 4 to 8 feet wide at the base. A narrow-base terrace is similar to a broad-base terrace, except for the width of the ridge and channel.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Ridge. A long, narrow elevation of the land surface, generally sharp crested with steep sides forming an extended upland between valleys.

Rill. A steep-sided channel resulting from accelerated

erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shoulder. The geomorphic component that forms the uppermost inclined surface at the top of a hillslope. It comprises the transition zone from back slope to summit of an upland. The surface is dominantly convex in profile and erosional in origin.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Side slope. The slope bounding a drainageway and lying between the drainageway and the adjacent interfluve (e.g., shoulder). It generally is linear along the slope width, and overland flow is parallel down the slope.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio. The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey the slope classes are as follows:

Nearly level	0 to 2 percent
Very gently sloping	1 to 3 percent
Gently sloping	2 to 5 percent
Moderately sloping	5 to 9 percent
Strongly sloping	9 to 14 percent
Moderately steep	14 to 25 percent

Steep	25 to 35 percent
Very steep	more than 35 percent

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the substratum. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind erosion and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind erosion and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summit. A general term for the top, or highest level, of an upland feature, such as a ridge or hill.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). A layer of otherwise suitable soil material that is too thin for the specified use.

Till plain. An extensive area of nearly level to

undulating soils underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Water break (or water bar). A hump or small dike-like surface drainage structure, properly used only in closing retired roads to traffic, on firelines, and on abandoned skid trails.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1960-90 at Oregon, Missouri)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	32.3	12.3	22.3	62	-15	1	0.92	0.33	1.49	2	5.6
February----	38.6	18.0	28.3	69	-9	3	1.00	.25	1.60	2	4.9
March-------	49.9	27.4	38.6	81	-1	33	2.41	1.02	3.59	5	2.6
April-------	65.5	41.2	53.4	89	15	178	3.13	1.77	4.34	6	.4
May---------	74.5	51.7	63.1	91	33	397	4.58	2.79	6.18	7	.0
June--------	83.3	61.0	72.1	97	46	664	4.56	2.47	6.40	7	.0
July--------	87.9	65.6	76.7	101	51	828	4.67	2.10	6.87	6	.0
August------	86.3	62.8	74.5	98	49	743	4.06	2.23	5.67	5	.0
September---	78.1	54.4	66.2	96	35	464	5.10	2.82	7.11	6	.0
October-----	68.3	43.7	56.0	90	22	233	2.59	.88	4.22	4	.1
November----	52.2	31.4	41.8	77	8	42	1.89	.45	3.19	3	.9
December----	37.8	19.4	28.6	67	-9	3	1.08	.37	1.86	2	4.3
Yearly:											
Average---	62.9	40.8	51.8	---	---	---	---	---	---	---	---
Extreme---	---	---	---	101	-16	---	---	---	---	---	---
Total-----	---	---	---	---	---	3,588	35.99	14.66	48.38	55	18.8

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1960-90 at Oregon, Missouri)

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 10	Apr. 20	May 1
2 years in 10 later than--	Apr. 6	Apr. 16	Apr. 27
5 years in 10 later than--	Mar. 27	Apr. 7	Apr. 19
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 20	Oct. 14	Oct. 3
2 years in 10 earlier than--	Oct. 25	Oct. 19	Oct. 8
5 years in 10 earlier than--	Nov. 4	Oct. 28	Oct. 17

TABLE 3.--GROWING SEASON

(Recorded in the period 1960-90 at Oregon, Missouri)

Probability	Daily minimum temperature during growing season		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	194	175	160
8 years in 10	200	183	167
5 years in 10	211	197	179
2 years in 10	221	211	191
1 year in 10	227	219	198

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
14	Blencoe silty clay, rarely flooded	10,070	3.4
15G	Vanmeter flaggy silt loam, 14 to 45 percent slopes	6,670	2.2
16	Colo silty clay loam, occasionally flooded	4,650	1.5
18B	Kenridge-Judson complex, 1 to 7 percent slopes	18,160	6.0
20D2	Contrary silt loam, 9 to 14 percent slopes, eroded	16,610	5.5
22	Dockery silt loam, clayey substratum, rarely flooded	4,700	1.6
26	Grable very fine sandy loam, frequently flooded	560	0.2
27	Grable-Leta complex, rarely flooded	6,760	2.2
28	Gilliam silt loam, rarely flooded	3,600	1.2
29	Grable very fine sandy loam, rarely flooded	3,240	1.1
30	Haynie silt loam, frequently flooded	1,440	0.5
32	Haynie silt loam, rarely flooded	6,350	2.1
34D2	Exira silty clay loam, 9 to 14 percent slopes, eroded	17,500	5.8
36B	Timula silt loam, 2 to 7 percent slopes	340	0.1
36D3	Timula silt loam, 9 to 14 percent slopes, severely eroded	5,920	2.0
36E3	Timula silt loam, 14 to 25 percent slopes, severely eroded	3,860	1.3
40	Kenmoor-Grable complex, rarely flooded	1,050	0.3
42C2	Knox silty clay loam, 5 to 9 percent slopes, eroded	2,620	0.9
42D2	Knox silty clay loam, 9 to 14 percent slopes, eroded	2,320	0.8
42E2	Knox silt loam, 14 to 20 percent slopes, eroded	6,240	2.1
42F	Knox silt loam, 20 to 35 percent slopes	680	0.2
44C2	Lamoni silty clay loam, 5 to 9 percent slopes, eroded	380	0.1
46	Luton clay, rarely flooded	25,160	8.4
50B	Marshall silty clay loam, 2 to 5 percent slopes	6,670	2.2
50C2	Marshall silty clay loam, 5 to 9 percent slopes, eroded	15,560	5.2
50D2	Marshall silty clay loam, 9 to 14 percent slopes, eroded	10,640	3.5
52	Motark silt loam, rarely flooded	6,010	2.0
54B	Monona silt loam, 2 to 5 percent slopes	5,690	1.9
54C2	Monona silt loam, 5 to 9 percent slopes, eroded	5,640	1.9
54D2	Monona silt loam, 9 to 14 percent slopes, eroded	3,680	1.2
56	Dupo silt loam, rarely flooded	5,180	1.7
57	Modale silt loam, rarely flooded	3,970	1.3
58B	Motark-Napier silt loams, 1 to 7 percent slopes	3,040	1.0
59B	Nodaway-Judson silt loams, 1 to 7 percent slopes	6,550	2.2
60	Nodaway silt loam, occasionally flooded	6,720	2.2
61B	Napier silt loam, 1 to 7 percent slopes	2,420	0.8
62B	Napier-Gullied land complex, 1 to 7 percent slopes	5,620	1.9
63	Leta silt loam, sandy substratum, rarely flooded	1,130	0.4
64	Leta silty clay, rarely flooded	10,630	3.5
65	Leta silty clay, frequently flooded	3,560	1.2
66	Leta silty clay, sandy substratum, rarely flooded	6,500	2.2
74	Sarpy loamy fine sand, rarely flooded	920	0.3
75	Sarpy fine sand, frequently flooded	650	0.2
78D2	Shelby clay loam, 9 to 14 percent slopes, eroded	13,450	4.5
79F	Timula-Knox silt loams, 14 to 35 percent slopes	6,430	2.1
80G	Timula-Hamburg silt loams, 14 to 90 percent slopes	4,060	1.4
81	Wabash silty clay, rarely flooded	11,170	3.7
82	Zook silty clay loam, occasionally flooded	46	*
84	Udifluvents, frequently flooded	210	0.1
85	Pits, quarries	540	0.2
	Water	5,119	1.7
	Total	300,685	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
14	Blencoe silty clay, rarely flooded
16	Colo silty clay loam, occasionally flooded (where drained)
18B	Kenridge-Judson complex, 1 to 7 percent slopes
22	Dockery silt loam, clayey substratum, rarely flooded
26	Grable very fine sandy loam, frequently flooded (where protected from flooding or not frequently flooded during the growing season)
27	Grable-Leta complex, rarely flooded
28	Gilliam silt loam, rarely flooded
29	Grable very fine sandy loam, rarely flooded
30	Haynie silt loam, frequently flooded (where protected from flooding or not frequently flooded during the growing season)
32	Haynie silt loam, rarely flooded
36B	Timula silt loam, 2 to 7 percent slopes
46	Luton clay, rarely flooded (where drained)
50B	Marshall silty clay loam, 2 to 5 percent slopes
52	Motark silt loam, rarely flooded
54B	Monona silt loam, 2 to 5 percent slopes
56	Dupo silt loam, rarely flooded
57	Modale silt loam, rarely flooded
58B	Motark-Napier silt loams, 1 to 7 percent slopes
59B	Nodaway-Judson silt loams, 1 to 7 percent slopes
60	Nodaway silt loam, occasionally flooded
61B	Napier silt loam, 1 to 7 percent slopes
63	Leta silt loam, sandy substratum, rarely flooded
64	Leta silty clay, rarely flooded
65	Leta silty clay, frequently flooded (where protected from flooding or not frequently flooded during the growing season)
66	Leta silty clay, sandy substratum, rarely flooded
81	Wabash silty clay, rarely flooded (where drained)
82	Zook silty clay loam, occasionally flooded (where drained)

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Corn (average)	Corn (range)	Soybeans	Winter wheat	Bromegrass-alfalfa hay	Bromegrass-alfalfa	Smooth bromegrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
14---------------- Blencoe	IIw	120	100-140	40	48	4.0	8.0	6.4
15G-------------- Vanmeter	VIIe	---	---	---	---	---	2.2	1.7
16---------------- Colo	IIw	125	90-135	42	50	4.2	8.4	6.7
18B:								
Kenridge---------	IIw	135	115-160	45	54	4.5	9.0	7.2
Judson-----------	IIe	140	120-159	46	54	4.6	9.2	7.4
20D2------------- Contrary	IIIe	111	87-120	35	42	3.6	7.2	5.8
22---------------- Dockery	IIw	130	90-150	48	58	5.0	9.6	7.7
26---------------- Grable	IIw	85	65-110	26	31	2.6	---	4.0
27:								
Grable-----------	IIs	110	85-125	35	42	3.6	7.2	5.7
Leta-------------	IIw	127	90-135	42	51	4.4	8.8	6.7
28---------------- Gilliam	IIw	145	100-160	47	57	4.8	9.5	7.6
29---------------- Grable	IIs	110	85-125	35	43	3.6	7.2	5.7
30---------------- Haynie	IIIw	108	87-120	34	41	3.3	6.8	5.4
32---------------- Haynie	I	137	95-142	45	54	4.5	9.0	7.2
34D2------------- Exira	IIIe	133	125-160	44	52	4.5	8.6	6.9
36B-------------- Timula	IIe	90	65-115	30	36	3.0	6.0	4.8
36D3------------- Timula	IVe	95	75-120	31	37	3.1	6.2	5.0
36E3------------- Timula	VIe	---	---	---	---	2.8	5.5	4.4
40:								
Kenmoor----------	IIIs	93	65-110	30	36	3.0	6.0	4.8
Grable-----------	IIs	110	85-125	35	43	3.6	7.2	5.7

See footnote at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn (average)	Corn (range)	Soybeans	Winter wheat	Bromegrass-alfalfa hay	Bromegrass-alfalfa	Smooth bromegrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
42C2------------ Knox	IIIe	115	80-120	37	44	3.7	7.4	5.9
42D2------------ Knox	IIIe	100	70-112	32	40	3.4	6.6	5.3
42E2------------ Knox	IVe	90	60-100	30	35	2.8	5.9	4.7
42F------------- Knox	VIe	---	---	---	---	---	---	4.7
44C2------------ Lamoni	IIIe	100	75-115	33	40	3.5	6.6	5.3
46-------------- Luton	IIIw	100	80-120	33	40	3.4	6.6	5.3
50B------------- Marshall	IIe	147	112-170	47	57	4.8	8.8	7.0
50C2------------ Marshall	IIIe	132	105-160	42	52	4.4	7.8	6.2
50D2------------ Marshall	IIIe	124	90-135	42	50	4.2	8.0	6.4
52-------------- Motark	I	140	110-155	44	53	4.5	8.8	7.0
54B------------- Monona	IIe	137	110-160	44	53	4.4	8.8	7.0
54C2------------ Monona	IIIe	127	100-150	42	51	3.9	7.8	6.2
54D2------------ Monona	IIIe	112	85-135	35	42	3.5	7.0	5.6
56-------------- Dupo	IIw	132	100-140	43	53	4.4	8.7	7.0
57-------------- Modale	IIw	140	105-160	46	55	4.6	9.0	7.2
58B:								
Motark---------	IIw	140	110-155	46	55	4.6	9.0	7.2
Napier---------	IIe	147	110-170	48	60	4.8	9.5	7.6
59B:								
Nodaway--------	IIw	140	112-189	46	55	4.3	9.0	7.2
Judson---------	IIe	140	120-159	45	54	4.5	9.0	7.2
60-------------- Nodaway	IIw	140	112-189	45	54	4.5	9.0	7.2
61B------------- Napier	IIe	147	110-170	48	60	4.8	9.5	7.6

See footnote at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn (average)	Corn (range)	Soybeans	Winter wheat	Bromegrass-alfalfa hay	Bromegrass-alfalfa	Smooth bromegrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
62B:								
Napier----------	IIe	147	110-170	48	60	4.8	9.6	7.7
Gullied land---	VIII	---	---	---	---	---	---	---
63, 64----------- Leta	IIw	127	90-127	42	51	4.8	9.5	7.6
65--------------- Leta	IIIw	93	65-110	30	36	3.0	6.0	4.8
66--------------- Leta	IIw	127	90-135	42	51	4.8	9.5	7.6
74--------------- Sarpy	IVs	---	---	20	24	2.0	4.0	3.2
75--------------- Sarpy	IVw	---	---	---	15	0.9	2.0	1.5
78D2------------- Shelby	IIIe	102	90-125	32	40	3.4	6.5	5.2
79F:								
Timula----------	VIe	---	---	---	---	2.9	5.8	4.6
Knox------------	VIe	---	---	---	---	2.9	5.8	4.6
80G:								
Timula----------	VIe	---	---	---	---	---	5.8	4.6
Hamburg---------	VIIe	---	---	---	---	---	5.0	4.0
81--------------- Wabash	IIIw	100	90-115	33	40	3.3	6.6	5.3
82--------------- Zook	IIw	103	70-120	32	40	3.4	6.8	5.4
84. Udifluvents								
85. Pits								

* Animal unit month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available)

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Potential productivity: Volume*	Trees to plant
15G------------- Vanmeter	2R	Severe	Severe	Severe	Severe	Northern red oak---- Black oak----------- Sugar maple---------	49 --- ---	33 --- ---	Black oak, eastern redcedar.
22-------------- Dockery	4A	Slight	Slight	Slight	Slight	Pin oak------------- Eastern cottonwood-- Green ash-----------	76 --- ---	58 --- ---	Pin oak, pecan, eastern cottonwood.
27: Grable.									
Leta-----------	7C	Slight	Moderate	Severe	Severe	Eastern cottonwood-- Black willow--------	90 ---	103 ---	Pecan, eastern cottonwood, silver maple, green ash.
28-------------- Gilliam	4A	Slight	Slight	Slight	Slight	Pin oak------------- Eastern cottonwood--	80 95	62 116	Pin oak, eastern cottonwood, pecan.
30, 32---------- Haynie	11A	Slight	Slight	Slight	Slight	Eastern cottonwood-- American sycamore--- Black walnut-------- Green ash-----------	107 110 --- ---	156 156 --- ---	Eastern cottonwood, black walnut.
36B, 36D3------- Timula	4A	Slight	Slight	Slight	Slight	Northern red oak---- Green ash----------- Bur oak-------------	65 --- ---	52 --- ---	White oak, northern red oak.
36E3------------ Timula	4R	Moderate	Moderate	Moderate	Slight	Northern red oak---- Green ash----------- Bur oak-------------	65 --- ---	52 --- ---	White oak, northern red oak.
40: Kenmoor--------	4S	Slight	Slight	Moderate	Slight	Pin oak------------- Eastern cottonwood-- Green ash-----------	75 85 ---	57 91 ---	Eastern cottonwood, pin oak, green ash.
Grable.									
42C2, 42D2------ Knox	4A	Slight	Slight	Slight	Slight	White oak----------- Northern red oak---- Black oak----------- Sugar maple---------	69 78 74 ---	51 60 56 ---	Northern red oak, green ash, black walnut, white oak.
42E2, 42F------- Knox	4R	Moderate	Moderate	Moderate	Slight	White oak----------- Northern red oak---- Black oak----------- Sugar maple---------	69 78 74 ---	51 60 56 ---	Northern red oak, green ash, black walnut.

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Potential productivity: Common trees	Site index	Volume*	Trees to plant
52--------------- Motark	9A	Slight	Slight	Slight	Slight	Eastern cottonwood-- Green ash----------- Black walnut--------	100 --- ---	128 --- ---	Eastern cottonwood, black walnut, northern red oak, white oak, green ash, pecan.
58B:									
Motark----------	9A	Slight	Slight	Slight	Slight	Eastern cottonwood-- Green ash----------- Black walnut--------	100 --- ---	128 --- ---	Eastern cottonwood, black walnut, northern red oak, white oak, green ash, pecan.
Napier.									
59B:									
Nodaway---------	3A	Slight	Slight	Slight	Slight	Black walnut-------- Cottonwood---------- Pin oak-------------	80 106 68	62 144 50	Northern red oak, black walnut, sugar maple, white oak.
Judson.									
60--------------- Nodaway	3A	Slight	Slight	Slight	Slight	Black walnut-------- Cottonwood---------- Pin oak-------------	80 106 68	62 144 50	Northern red oak, black walnut, sugar maple, white oak.
63--------------- Leta	7C	Slight	Moderate	Severe	Severe	Eastern cottonwood-- Silver maple-------- Black willow--------	90 85 ---	103 38 ---	Pecan, eastern cottonwood, silver maple, green ash.
64--------------- Leta	7C	Slight	Moderate	Severe	Severe	Eastern cottonwood-- Black willow--------	90 ---	103 ---	Pecan, eastern cottonwood, silver maple, green ash.
65--------------- Leta	7W	Slight	Moderate	Severe	Severe	Eastern cottonwood-- Black willow--------	90 ---	103 ---	Pecan, eastern cottonwood, silver maple, green ash.
66--------------- Leta	7C	Slight	Moderate	Severe	Severe	Eastern cottonwood-- Silver maple-------- Black willow--------	90 85 ---	103 38 ---	Pecan, eastern cottonwood, silver maple, green ash.
74, 75----------- Sarpy	3S	Slight	Slight	Severe	Slight	Silver maple-------- Eastern cottonwood--	90 92	42 108	Eastern cottonwood, American sycamore, black willow.

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Potential productivity: Volume*	Trees to plant
79F:									
Timula	4R	Moderate	Moderate	Moderate	Slight	White oak	70	52	White oak.
						Northern red oak	75	57	
						Bur oak	---	---	
Knox	4R	Moderate	Moderate	Moderate	Slight	White oak	69	51	Northern red oak, green ash, black walnut, white oak.
						Northern red oak	78	57	
						Black oak	74	56	
						Sugar maple	---	---	
80G:									
Timula	4R	Moderate	Moderate	Moderate	Slight	White oak	70	52	White oak.
						Northern red oak	75	57	
						Bur oak	---	---	
Hamburg	2R	Severe	Severe	Severe	Slight	Black oak	52	36	Bur oak, eastern redcedar, white oak.
						Bur oak	---	---	
						Eastern redcedar	---	---	
						Post oak	---	---	
81 Wabash	4W	Slight	Severe	Severe	Moderate	Pin oak	75	57	Pin oak, pecan, eastern cottonwood.

* Volume is the yield in cubic feet per acre per year calculated at the age of culmination of mean annual increment for fully stocked natural stands.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
14----------------- Blencoe	---	Lilac, Amur maple, American plum, blackhaw.	Eastern redcedar, white fir, Washington hawthorn.	Austrian pine, green ash, pin oak, eastern white pine, honeylocust, hackberry.	Eastern cottonwood.
15G---------------- Vanmeter	Fragrant sumac----	Siberian peashrub, wahoo.	Honeylocust, northern catalpa, green ash, Russian-olive, bur oak, black locust, eastern redcedar.	Lace-bark elm-----	---
16----------------- Colo	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple, eastern cottonwood.	---
18B:					
Kenridge----------	---	American plum, common chokecherry, Peking cotoneaster, lilac, Nanking cherry, Siberian peashrub.	Eastern redcedar	Austrian pine, Scotch pine, ponderosa pine, hackberry, green ash, golden willow, honeylocust, pin oak, black walnut.	Eastern cottonwood, silver maple.
Judson------------	---	American plum, Amur maple, lilac, arrowwood.	Hackberry, bur oak, green ash, Russian-olive, eastern redcedar.	Honeylocust, Austrian pine, eastern white pine.	---
20D2--------------- Contrary	---	Arrowwood, Amur maple, autumn-olive, lilac.	Eastern redcedar, bur oak, hackberry, green ash, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
22----------------- Dockery	Fragrant sumac----	American plum, blackhaw, silky dogwood.	Nannyberry viburnum, Washington hawthorn, white fir.	Green ash, eastern white pine, Norway spruce.	Pin oak, eastern cottonwood.
26----------------- Grable	Blackhaw----------	Siberian peashrub	Russian-olive, Washington hawthorn, eastern redcedar.	Honeylocust, bur oak, green ash, hackberry.	Eastern cottonwood.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
27:					
Grable	---	Siberian peashrub	Nannyberry viburnum, Washington hawthorn, white spruce, northern whitecedar, eastern redcedar, green ash.	Black willow, golden willow.	Eastern cottonwood.
Leta	---	American plum, blackhaw, Washington hawthorn, nannyberry viburnum.	Eastern redcedar, green ash, northern whitecedar, sweetgum, white spruce.	Bur oak	---
28 Gilliam	Blackhaw	Siberian peashrub	Washington hawthorn, eastern redcedar, Russian-olive.	Honeylocust, hackberry, bur oak, green ash.	Eastern cottonwood.
29 Grable	Blackhaw	Siberian peashrub	Russian-olive, Washington hawthorn, eastern redcedar.	Honeylocust, bur oak, green ash, hackberry.	Eastern cottonwood.
30, 32 Haynie	Blackhaw	Siberian peashrub	Russian-olive, eastern redcedar, Washington hawthorn.	Green ash, hackberry, honeylocust, bur oak.	Eastern cottonwood.
34D2 Exira	---	Amur privet, American cranberrybush, silky dogwood.	White fir, blue spruce, northern whitecedar, Washington hawthorn.	Norway spruce, Austrian pine.	Eastern white pine, pin oak.
36B, 36D3, 36E3 Timula	---	Russian-olive, eastern redcedar, Washington hawthorn.	Honeylocust, green ash.	---	---
40:					
Kenmoor	---	American plum, nannyberry viburnum, Washington hawthorn, holly.	Eastern redcedar, northern whitecedar, sweetgum, white spruce, green ash.	Bur oak	---
Grable	---	Siberian peashrub	Nannyberry viburnum, Washington hawthorn, white spruce, northern whitecedar, eastern redcedar, green ash.	Black willow, golden willow.	Eastern cottonwood.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
42C2, 42D2, 42E2, 42F: Knox	---	Arrowwood, American plum, lilac, Amur maple.	Hackberry, eastern redcedar, green ash, bur oak, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
44C2: Lamoni	---	Eastern redcedar, Washington hawthorn, arrowwood, Amur privet, American cranberrybush.	Austrian pine, green ash.	Eastern white pine, pin oak.	---
46: Luton	Redosier dogwood	Common chokecherry, American plum.	Hackberry, eastern redcedar.	Silver maple, Austrian pine, golden willow, green ash, honeylocust, northern red oak.	Eastern cottonwood.
50B, 50C2, 50D2: Marshall	---	Autumn-olive, lilac, Amur maple.	Eastern redcedar, Russian-olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---
52: Motark	Redosier dogwood, fragrant sumac.	American plum, blackhaw.	White fir, nannyberry viburnum, Washington hawthorn.	Green ash, eastern white pine, Norway spruce.	Pin oak, eastern cottonwood.
54B, 54C2, 54D2: Monona	---	Arrowwood, American plum, lilac, Amur maple.	Bur oak, hackberry, green ash, Russian-olive, eastern redcedar.	Honeylocust, eastern white pine, Austrian pine.	---
55: Dupo	---	Amur privet, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern whitecedar, Washington hawthorn.	Norway spruce	Eastern white pine, pin oak.
57: Modale	Blackhaw	Siberian peashrub	Washington hawthorn, Russian-olive, eastern redcedar.	Honeylocust, bur oak, green ash, hackberry.	Eastern cottonwood.
58B: Motark	Redosier dogwood, fragrant sumac.	American plum, blackhaw.	White fir, nannyberry viburnum, Washington hawthorn.	Green ash, eastern white pine, Norway spruce.	Pin oak, eastern cottonwood.
Napier	---	Arrowwood, American plum, autumn-olive, Amur maple.	Bur oak, eastern redcedar, Russian-olive, hackberry, green ash.	Austrian pine, honeylocust, eastern white pine.	---

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
59B:					
Nodaway	---	Blackhaw, American plum, Amur maple, lilac.	Eastern redcedar	Austrian pine, hackberry, honeylocust, green ash, eastern white pine, pin oak.	Eastern cottonwood.
Judson	---	Arrowwood, American plum, Amur maple, lilac.	Hackberry, bur oak, green ash, Russian-olive, eastern redcedar.	Honeylocust, Austrian pine, eastern white pine.	---
60 Nodaway	---	Blackhaw, Amur maple, lilac, American plum.	Eastern redcedar	Austrian pine, hackberry, honeylocust, green ash, eastern white pine, pin oak.	Eastern cottonwood.
61B Napier	---	Lilac, arrowwood, Amur maple, American plum.	Bur oak, eastern redcedar, Russian-olive, hackberry, green ash.	Austrian pine, honeylocust, eastern white pine.	---
62B:					
Napier	---	Lilac, arrowwood, Amur maple, American plum.	Bur oak, eastern redcedar, Russian-olive, hackberry, green ash.	Austrian pine, honeylocust, eastern white pine.	---
Gullied land.					
63 Leta	---	American plum, blackhaw, Washington hawthorn, nannyberry viburnum.	Green ash, sweetgum, white spruce, northern whitecedar, eastern redcedar.	Bur oak	---
64, 65 Leta	---	American plum, blackhaw, Washington hawthorn, nannyberry viburnum.	Eastern redcedar, green ash, northern whitecedar, sweetgum, white spruce.	Bur oak	---
66 Leta	---	American plum, blackhaw, Washington hawthorn, nannyberry viburnum.	Green ash, sweetgum, white spruce, northern whitecedar, eastern redcedar.	Bur oak	---
74 Sarpy	Blackhaw	Washington hawthorn, Siberian peashrub.	Eastern redcedar, Russian-olive.	Honeylocust, hackberry, green ash, bur oak.	Eastern cottonwood.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
75. Sarpy	Blackhaw	Siberian peashrub, Washington hawthorn.	Eastern redcedar, Russian-olive.	Bur oak, hackberry, green ash, honeylocust.	Eastern cottonwood.
78D2. Shelby	---	Arrowwood, lilac, Amur honeysuckle, Amur maple, American plum.	Eastern redcedar, Russian-olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---
79F:					
Timula	---	Russian-olive, eastern redcedar, Washington hawthorn.	Honeylocust, green ash.	---	---
Knox	---	Arrowwood, lilac, Amur maple, American plum.	Hackberry, eastern redcedar, green ash, bur oak, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
80G:					
Timula	---	Russian-olive, eastern redcedar, Washington hawthorn.	Honeylocust, green ash.	---	---
Hamburg	Fragrant sumac	Siberian peashrub	Eastern redcedar, honeylocust, green ash, Russian-olive, bur oak.	Siberian elm	---
81. Wabash	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple.	Eastern cottonwood.
82. Zook	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Honeylocust, golden willow, green ash, northern red oak, silver maple, Austrian pine.	Eastern cottonwood.
84. Udifluvents					
85. Pits					

TABLE 9.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
14: Blencoe	Severe: flooding, too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.
15G: Vanmeter	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: large stones, slope, percs slowly.	Severe: slope.	Severe: slope.
16: Colo	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
18B:					
Kenridge	Severe: flooding.	Moderate: percs slowly.	Moderate: flooding, percs slowly.	Slight	Moderate: flooding.
Judson	Slight	Slight	Moderate: slope.	Slight	Slight.
20D2: Contrary	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
22: Dockery	Severe: flooding.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.
26: Grable	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
27:					
Grable	Severe: flooding.	Slight	Slight	Slight	Slight.
Leta	Severe: flooding, wetness, too clayey.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.
28: Gilliam	Severe: flooding.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.
29: Grable	Severe: flooding.	Slight	Slight	Slight	Slight.
30: Haynie	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
32: Haynie	Severe: flooding.	Slight	Slight	Slight	Slight.
34D2: Exira	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
36B: Timula	Slight	Slight	Moderate: slope.	Severe: erodes easily.	Slight.
36D3: Timula	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: slope.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
36E3 Timula	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.	Severe: slope.
40:					
Kenmoor	Severe: flooding.	Moderate: wetness, percs slowly.	Moderate: wetness.	Slight	Moderate: droughty.
Grable	Severe: flooding.	Slight	Slight	Slight	Slight.
42C2 Knox	Slight	Slight	Severe: slope.	Slight	Slight.
42D2 Knox	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
42E2 Knox	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
42F Knox	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
44C2 Lamoni	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness, percs slowly.	Severe: erodes easily.	Moderate: wetness.
46 Luton	Severe: flooding, wetness, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness, percs slowly.	Severe: too clayey.	Severe: too clayey.
50 Marshall	Slight	Slight	Moderate: slope.	Slight	Slight.
50C2 Marshall	Slight	Slight	Severe: slope.	Slight	Slight.
50D2 Marshall	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
52 Motark	Severe: flooding.	Slight	Slight	Slight	Slight.
54B Monona	Slight	Slight	Moderate: slope.	Slight	Slight.
54C2 Monona	Slight	Slight	Severe: slope.	Slight	Slight.
54D2 Monona	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
56 Dupo	Severe: flooding.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
57 Modale	Severe: flooding, percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Moderate: wetness.	Moderate: wetness.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
58B:					
Motark	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
Napier	Slight	Slight	Moderate: slope.	Slight	Slight.
59B:					
Nodaway	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
Judson	Slight	Slight	Moderate: slope.	Slight	Slight.
60 Nodaway	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
61B Napier	Slight	Slight	Moderate: slope.	Slight	Slight.
62B:					
Napier	Slight	Slight	Moderate: slope.	Slight	Slight.
Gullied land.					
63 Leta	Severe: flooding, wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
64 Leta	Severe: flooding, wetness, too clayey.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.
65 Leta	Severe: flooding, wetness, too clayey.	Severe: too clayey.	Severe: too clayey, wetness, flooding.	Severe: too clayey.	Severe: flooding, too clayey.
66 Leta	Severe: flooding, wetness, too clayey.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.
74 Sarpy	Severe: flooding.	Slight	Slight	Slight	Moderate: droughty.
75 Sarpy	Severe: flooding, too sandy.	Severe: too sandy.	Severe: too sandy, flooding.	Severe: too sandy.	Severe: flooding.
78D2 Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
79F:					
Timula	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.	Severe: slope.
Knox	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
80G:					
Timula	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.	Severe: slope.
Hamburg	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, erodes easily.	Severe: slope.
81 Wabash	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
82 Zook	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
84. Udifluvents					
85. Pits					

TABLE 10.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
14: Blencoe	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
15G: Vanmeter	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
16: Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
18B:										
Kenridge	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Judson	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
20D2: Contrary	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
22: Dockery	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
26: Grable	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.
27:										
Grable	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Leta	Fair	Fair	Poor	Good	Good	Poor	Fair	Fair	Fair	Poor.
28: Gilliam	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
29: Grable	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.
30: Haynie	Fair	Fair	Fair	Fair	Poor	Poor	Poor	Fair	Fair	Poor.
32: Haynie	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
34D2: Exira	Good	Good	Good	Fair	Fair	Poor	Poor	Good	Fair	Poor.
36B, 36D3: Timula	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
36E3: Timula	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
40:										
Kenmoor	Poor	Fair	Good	Good	Good	Poor	Fair	Fair	Good	Poor.
Grable	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Hardwood trees	Conif-erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
42C2, 42D2---------- Knox	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
42E2---------------- Knox	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
42F----------------- Knox	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
44C2---------------- Lamoni	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
46------------------ Luton	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
50B----------------- Marshall	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
50C2, 50D2---------- Marshall	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
52------------------ Motark	Good	Good	Good	Good	Good	Fair	Poor	Good	Good	Fair.
54B, 54C2, 54D2----- Monona	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
56------------------ Dupo	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
57------------------ Modale	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
58B:										
Motark--------------	Good	Good	Good	Good	Good	Fair	Poor	Good	Good	Fair.
Napier--------------	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
59B:										
Nodaway-------------	Good	Good	Good	Good	Fair	Fair	Poor	Fair	Good	Fair.
Judson--------------	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
60------------------ Nodaway	Good	Good	Good	Good	Fair	Fair	Poor	Fair	Good	Fair.
61B----------------- Napier	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
62B:										
Napier--------------	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Gullied land.										
63, 64, 65, 66------ Leta	Fair	Fair	Poor	Good	Good	Poor	Fair	Fair	Fair	Poor.
74, 75-------------- Sarpy	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
78D2 Shelby	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
79F:										
Timula	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Knox	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
80G:										
Timula	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Hamburg	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
81 Wabash	Poor	Poor	Poor	Poor	Poor	Poor	Good	Poor	Poor	Fair.
82 Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
84. Udifluvents										
85. Pits										

TABLE 11.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
14: Blencoe	Severe: wetness.	Severe: flooding, shrink-swell.	Severe: flooding, wetness.	Severe: flooding, shrink-swell.	Severe: shrink-swell, low strength, frost action.	Severe: too clayey.
15G: Vanmeter	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength, slope.	Severe: slope.
16: Colo	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness.
18B:						
Kenridge	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: flooding.
Judson	Slight	Slight	Moderate: shrink-swell.	Moderate: slope.	Severe: low strength, frost action.	Slight.
20D2: Contrary	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
22: Dockery	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: low strength, frost action.	Moderate: wetness.
26: Grable	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
27:						
Grable	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.	Slight.
Leta	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: frost action.	Severe: too clayey.
28: Gilliam	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: low strength, frost action.	Moderate: wetness.
29: Grable	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.	Slight.
30: Haynie	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Severe: flooding.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
32----------------- Haynie	Slight---------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.	Slight.
34D2--------------- Exira	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
36B---------------- Timula	Moderate: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Severe: frost action.	Slight.
36D3--------------- Timula	Moderate: cutbanks cave, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
36E3--------------- Timula	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action.	Severe: slope.
40:						
Kenmoor-----------	Severe: cutbanks cave, wetness.	Severe: flooding.	Severe: flooding, wetness, shrink-swell.	Severe: flooding.	Moderate: wetness, flooding, frost action.	Moderate: droughty.
Grable------------	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.	Slight.
42C2--------------- Knox	Slight---------	Moderate: shrink-swell.	Slight---------	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
42D2--------------- Knox	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
42E2, 42F---------- Knox	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope.
44C2--------------- Lamoni	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength.	Moderate: wetness.
46----------------- Luton	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength.	Severe: too clayey.
50B---------------- Marshall	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
50C2--------------- Marshall	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
50D2--------------- Marshall	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
52----------------- Motark	Moderate: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: frost action.	Slight.
54B---------------- Monona	Slight----------	Moderate: shrink-swell.	Slight----------	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
54C2--------------- Monona	Slight----------	Moderate: shrink-swell.	Slight----------	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
54D2--------------- Monona	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
56----------------- Dupo	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness, shrink-swell.	Severe: flooding.	Severe: low strength, frost action.	Moderate: wetness.
57----------------- Modale	Severe: wetness.	Severe: flooding, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, shrink-swell.	Severe: shrink-swell, low strength.	Moderate: wetness.
58B:						
Motark------------	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action.	Moderate: flooding.
Napier------------	Slight----------	Slight----------	Slight----------	Moderate: slope.	Severe: low strength, frost action.	Slight.
59B:						
Nodaway-----------	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: flooding.
Judson------------	Slight----------	Slight----------	Moderate: shrink-swell.	Moderate: slope.	Severe: low strength, frost action.	Slight.
60----------------- Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: flooding.
61B---------------- Napier	Slight----------	Slight----------	Slight----------	Moderate: slope.	Severe: low strength, frost action.	Slight.
62B:						
Napier------------	Slight----------	Slight----------	Slight----------	Moderate: slope.	Severe: low strength, frost action.	Slight.
Gullied land.						

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
63----------------- Leta	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: frost action.	Moderate: wetness.
64----------------- Leta	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: frost action.	Severe: too clayey.
65----------------- Leta	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, frost action.	Severe: flooding, too clayey.
66----------------- Leta	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: frost action.	Severe: too clayey.
74----------------- Sarpy	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.	Moderate: droughty.
75----------------- Sarpy	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
78D2--------------- Shelby	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
79F: Timula------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action.	Severe: slope.
Knox--------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope.
80G: Timula------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action.	Severe: slope.
Hamburg-----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action.	Severe: slope.
81----------------- Wabash	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness, too clayey.
82----------------- Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.
84. Udifluvents						
85. Pits						

TABLE 12.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
14 Blencoe	Severe: wetness, percs slowly.	Moderate: seepage.	Severe: wetness.	Severe: wetness.	Fair: wetness.
15G Vanmeter	Severe: depth to rock, percs slowly, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: depth to rock, slope.
16 Colo	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
18B: Kenridge	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: too clayey, wetness.
Judson	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
20D2 Contrary	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
22 Dockery	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
26 Grable	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, too sandy.	Severe: flooding, seepage.	Poor: seepage, too sandy.
27: Grable	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too sandy.
Leta	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
28 Gilliam	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
29 Grable	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
30 Haynie	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
32 Haynie	Moderate: flooding, percs slowly.	Moderate: seepage.	Moderate: flooding.	Moderate: flooding.	Good.
34D2 Exira	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
36B Timula	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
36D3 Timula	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
36E3 Timula	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
40:					
Kenmoor	Severe: wetness, percs slowly.	Severe: seepage.	Severe: too clayey.	Severe: seepage.	Poor: too clayey, hard to pack.
Grable	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too sandy.
42C2 Knox	Slight	Severe: slope.	Slight	Slight	Good.
42D2 Knox	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
42E2, 42F Knox	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
44C2 Lamoni	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
46 Luton	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
50B Marshall	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
50C2 Marshall	Slight	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
50D2 Marshall	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
52 Motark	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
54B Monona	Slight	Moderate: seepage, slope.	Slight	Slight	Good.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
54C2 Monona	Slight	Severe: slope.	Slight	Slight	Good.
54D2 Monona	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
56 Dupo	Severe: wetness, percs slowly.	Moderate: seepage.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
57 Modale	Severe: wetness, percs slowly.	Moderate: seepage.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
58B:					
Motark	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
Napier	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
59B:					
Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: too clayey, wetness.
Judson	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
60 Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: too clayey, wetness.
61B Napier	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
62B:					
Napier	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Gullied land.					
63 Leta	Severe: wetness, percs slowly.	Severe: seepage.	Severe: seepage, wetness.	Severe: wetness.	Poor: wetness, thin layer.
64 Leta	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
65 Leta	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
66 Leta	Severe: wetness, percs slowly.	Severe: seepage.	Severe: seepage, wetness.	Severe: wetness.	Poor: wetness, thin layer.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
74 Sarpy	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
75 Sarpy	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, too sandy.	Severe: flooding, seepage.	Poor: seepage, too sandy.
78D2 Shelby	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
79F:					
Timula	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Knox	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
80G:					
Timula	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Hamburg	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
81 Wabash	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
82 Zook	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
84. Udifluvents					
85. Pits					

TABLE 13.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
14: Blencoe	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
15G: Vanmeter	Poor: depth to rock, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, slope.
16: Colo	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
18B:				
Kenridge	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
20D2: Contrary	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
22: Dockery	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
26: Grable	Good	Probable	Improbable: too sandy.	Fair: thin layer.
27:				
Grable	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
Leta	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
28: Gilliam	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
29: Grable	Good	Probable	Improbable: too sandy.	Fair: thin layer.
30, 32: Haynie	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
34D2: Exira	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
36B: Timula	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
36D3: Timula	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
36E3: Timula	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
40:				
Kenmoor	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
Grable	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
42C2 Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
42D2 Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
42E2 Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
42F Knox	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
44C2 Lamoni	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
46 Luton	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
50B Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
50C2 Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
50D2 Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
52 Motark	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
54B Monona	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
54C2 Monona	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
54D2 Monona	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
56 Dupo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
57 Modale	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
58B:				
Motark	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Napier	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
59B:				
Nodaway	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
60 Nodaway	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
61B Napier	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
62B:				
Napier	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Gullied land.				
63 Leta	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
64, 65 Leta	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
66 Leta	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
74, 75 Sarpy	Good	Probable	Improbable: too sandy.	Poor: too sandy.
78D2 Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
79F:				
Timula	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
80G:				
Timula	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Hamburg	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
81 Wabash	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
82-------------------- Zook	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
84. Udifluvents				
85. Pits				

TABLE 14.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
14 Blencoe	Moderate: seepage.	Severe: piping, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
15G Vanmeter	Severe: slope.	Slight	Deep to water	Slope, percs slowly, depth to rock.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
16 Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
18B:						
Kenridge	Slight	Moderate: wetness.	Deep to water	Flooding	Favorable	Favorable.
Judson	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
20D2 Contrary	Severe: slope.	Moderate: thin layer, piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
22 Dockery	Moderate: seepage.	Severe: wetness.	Frost action	Wetness, percs slowly, erodes easily.	Erodes easily, wetness.	Erodes easily.
26 Grable	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing	Erodes easily, too sandy, soil blowing.	Erodes easily.
27:						
Grable	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing	Erodes easily, soil blowing.	Erodes easily.
Leta	Moderate: seepage.	Severe: piping, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness	Wetness, percs slowly.
28 Gilliam	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Wetness	Favorable.
29 Grable	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing	Erodes easily, too sandy, soil blowing.	Erodes easily.
30, 32 Haynie	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
34D2 Exira	Severe: slope.	Slight	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
36B Timula	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
36D3, 36E3: Timula	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
40: Kenmoor	Severe: seepage.	Severe: hard to pack.	Percs slowly	Wetness, droughty.	Wetness, soil blowing, percs slowly.	Droughty, percs slowly.
Grable	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing	Erodes easily, soil blowing.	Erodes easily.
42C2: Knox	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
42D2, 42E2, 42F: Knox	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
44C2: Lamoni	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Slope, wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
46: Luton	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
50B, 50C2: Marshall	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
50D2: Marshall	Severe: slope.	Slight	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
52: Motark	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
54B, 54C2: Monona	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
54D2: Monona	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
56: Dupo	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
57: Modale	Moderate: seepage.	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
58B: Motark	Moderate: seepage.	Severe: piping.	Flooding, frost action.	Wetness, flooding.	Wetness	Favorable.
Napier	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
59B: Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
59B:						
Judson	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
60 Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
61B Napier	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
62B:						
Napier	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Gullied land.						
63 Leta	Severe: seepage.	Severe: piping, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness	Wetness, percs slowly.
64 Leta	Moderate: seepage.	Severe: piping, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness	Wetness, percs slowly.
65 Leta	Moderate: seepage.	Severe: piping, wetness.	Percs slowly, flooding, frost action.	Wetness, slow intake, percs slowly.	Wetness	Wetness, percs slowly.
66 Leta	Severe: seepage.	Severe: piping, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness	Wetness, percs slowly.
74, 75 Sarpy	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake.	Too sandy, soil blowing.	Droughty.
78D2 Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
79F:						
Timula	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Knox	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
80G:						
Timula	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Hamburg	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
81 Wabash	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
82 Zook	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
84. Udifluvents						
85. Pits						

TABLE 15.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 10 inches	Fragments 3-10 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct	Pct					Pct	
14------------ Blencoe	0-20	Silty clay----	CH	A-7	0	0	100	100	95-100	95-100	60-85	30-50
	20-28	Silty clay loam, silty clay.	CL, CH	A-7	0	0	100	100	95-100	90-100	41-60	20-30
	28-60	Silt loam-----	ML, CL	A-4, A-6	0	0	100	100	95-100	85-100	30-40	5-15
15G----------- Vanmeter	0-7	Flaggy silt loam.	CL-ML, CL	A-4, A-6, A-7	0-5	5-15	95-100	75-100	70-100	65-100	25-45	5-20
	7-10	Silty clay loam, clay loam.	CL, CH	A-7	0	0-5	95-100	75-100	70-100	65-100	40-55	15-30
	10-22	Silty clay, clay.	CH, CL	A-7	0	0-5	95-100	75-100	70-100	65-100	40-65	24-40
	22-60	Weathered bedrock.	---	---	---	---	---	---	---	---	---	---
16------------ Colo	0-27	Silty clay loam.	CL, CH	A-7	0	0	100	100	90-100	90-100	40-60	15-30
	27-50	Silty clay loam.	CL, CH	A-7	0	0	100	100	90-100	90-100	40-55	20-30
	50-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	0	100	100	95-100	80-100	40-55	15-30
18B:												
Kenridge-----	0-45	Silty clay loam.	CL	A-7	0	0	100	100	95-100	85-95	40-45	15-20
	45-60	Silty clay loam.	CL	A-7	0	0	100	100	95-100	85-95	40-47	15-22
Judson--------	0-24	Silt loam-----	CL, CL-ML	A-4, A-6	0	0	100	100	100	95-100	25-35	5-15
	24-60	Silty clay loam.	CL	A-6, A-7	0	0	100	100	100	95-100	30-50	15-25
20D2---------- Contrary	0-5	Silt loam-----	CL	A-6	0	0	100	100	90-100	85-90	30-40	10-15
	5-46	Silt loam, silty clay loam.	CL	A-6, A-7	0	0	100	100	90-100	85-95	30-45	10-20
	46-60	Silt loam-----	CL, ML	A-6, A-4	0	0	100	100	90-100	85-90	30-40	5-15
22------------ Dockery	0-9	Silt loam-----	CL-ML, CL	A-4, A-6	0	0	100	100	90-100	70-90	25-35	7-15
	9-49	Silt loam, silty clay loam.	CL	A-4, A-6	0	0	100	100	90-100	70-95	28-40	9-20
	49-60	Silty clay----	CL, CH	A-7	0	0	100	100	95-100	90-95	45-60	22-35
26------------ Grable	0-8	Very fine sandy loam.	CL, CL-ML	A-4	0	0	100	100	80-95	50-75	20-30	5-10
	8-18	Silt loam, very fine sandy loam.	CL, CL-ML	A-4, A-6	0	0	100	100	80-95	80-95	<25	5-15
	18-60	Fine sand, loamy sand, sand.	SM, SC-SM, SP-SM	A-2, A-3	0	0	100	100	65-80	5-35	<20	NP-5

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 10 inches	Fragments 3-10 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO			4	10	40	200		
	In				Pct	Pct					Pct	
27:												
Grable	0-8	Very fine sandy loam.	CL-ML, ML	A-4	0	0	100	100	80-95	80-95	<25	NP-5
	8-24	Very fine sandy loam, silt loam.	CL, CL-ML	A-4	0	0	100	100	80-95	80-95	20-30	5-10
	24-40	Loamy fine sand, fine sand.	SM, SP-SM, SC-SM	A-2, A-3	0	0	100	100	65-80	5-35	<20	NP-5
	40-60	Stratified loamy fine sand to silt loam.	CL, ML, SM, SC	A-4, A-2-4	0	0	100	100	70-90	25-70	20-30	NP-10
Leta	0-18	Silty clay	CL, CH	A-7	0	0	100	100	95-100	95-100	45-65	30-45
	18-33	Silty clay loam, silty clay.	CL, CH	A-6, A-7	0	0	100	100	95-100	90-100	35-65	20-40
	33-60	Stratified silt loam to sandy loam.	CL-ML, CL	A-4, A-6	0	0	100	100	80-100	51-95	20-35	5-15
28 Gilliam	0-12	Silt loam	CL	A-6, A-4	0	0	100	100	95-100	85-100	25-40	8-20
	12-23	Silt loam, silty clay loam, loam.	CL	A-6, A-4	0	0	100	100	90-100	80-95	25-40	8-20
	23-60	Stratified silty clay loam to loam.	CL-ML, CL	A-4, A-6	0	0	100	100	90-100	80-95	20-40	5-20
29 Grable	0-8	Very fine sandy loam.	CL, CL-ML	A-4	0	0	100	100	80-95	50-75	20-30	5-10
	8-30	Silt loam, very fine sandy loam.	CL, CL-ML	A-4, A-6	0	0	100	100	80-95	80-95	<25	5-15
	30-60	Fine sand, loamy sand, sand.	SM, SC-SM, SP-SM	A-2, A-3	0	0	100	100	65-80	5-35	<20	NP-5
30, 32 Haynie	0-8	Silt loam	CL-ML, CL	A-4, A-6	0	0	100	100	85-100	70-100	25-40	5-15
	8-60	Silt loam, very fine sandy loam.	CL-ML, CL	A-4, A-6	0	0	100	100	85-100	85-100	25-35	5-15
34D2 Exira	0-10	Silty clay loam.	CL	A-6, A-7	0	0	100	100	100	95-100	35-50	15-25
	10-36	Silty clay loam, silt loam.	CL, ML	A-7, A-6	0	0	100	100	100	95-100	35-50	15-25
	36-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	0	100	100	100	95-100	35-50	15-25
36B, 36D3, 36E3 Timula	0-5	Silt loam	ML	A-4	0	0	100	100	95-100	85-100	25-35	NP-10
	5-60	Silt loam, silt.	ML	A-4	0	0	100	100	95-100	85-100	25-35	NP-10

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification Unified	Classification AASHTO	Fragments > 10 inches	Fragments 3-10 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct	Pct					Pct	
40:												
Kenmoor-------	0-10	Fine sandy loam.	ML, SM, CL-ML, SC-SM	A-4	0	0	100	100	80-95	45-65	<25	NP-5
	10-27	Sand, loamy fine sand, fine sand.	SM	A-2, A-4	0	0	100	100	65-80	15-40	---	NP
	27-60	Silty clay loam, silty clay, clay.	CH, CL	A-7	0	0	100	100	95-100	75-95	40-70	25-45
Grable--------	0-8	Very fine sandy loam.	CL-ML, ML	A-4	0	0	100	100	80-95	80-95	<25	NP-5
	8-24	Very fine sandy loam, silt loam.	CL, CL-ML	A-4	0	0	100	100	80-95	80-95	20-30	5-10
	24-35	Loamy fine sand, fine sand.	SM, SP-SM, SC-SM	A-2, A-3	0	0	100	100	65-80	5-35	<20	NP-5
	35-60	Stratified loamy fine sand to silt loam.	CL, ML, SM, SC	A-4, A-2-4	0	0	100	100	70-90	25-70	20-30	NP-10
42C2, 42D2---- Knox	0-8	Silty clay loam.	CL	A-6	0	0	100	100	95-100	95-100	30-35	10-15
	8-47	Silty clay loam, silt loam.	CL	A-7	0	0	100	100	95-100	95-100	40-50	20-30
	47-60	Silt loam-----	CL	A-6, A-7	0	0	100	100	95-100	90-100	30-45	10-25
42E2, 42F----- Knox	0-12	Silt loam-----	CL-ML, CL, ML	A-4, A-6	0	0	100	100	95-100	90-100	20-35	2-15
	12-45	Silty clay loam, silt loam.	CL	A-7	0	0	100	100	95-100	95-100	40-50	20-30
	45-60	Silt loam-----	CL	A-6, A-7	0	0	100	100	95-100	90-100	30-45	10-25
44C2---------- Lamoni	0-8	Silty clay loam.	CL	A-6, A-7	0	0	95-100	95-100	80-95	70-95	35-45	15-25
	8-48	Clay loam, clay.	CH	A-7	0	0	95-100	95-100	90-100	85-100	50-60	25-35
	48-60	Clay loam-----	CL	A-6, A-7	0	0	95-100	95-100	70-90	55-85	35-50	15-30
46------------ Luton	0-7	Clay----------	CH	A-7	0	0	100	100	95-100	95-100	60-85	35-60
	7-60	Silty clay, clay.	CH	A-7	0	0	100	100	95-100	95-100	60-85	35-60
50B----------- Marshall	0-19	Silty clay loam.	CL	A-6, A-7	0	0	100	100	100	95-100	35-50	15-25
	19-40	Silty clay loam.	CL	A-7, A-6	0	0	100	100	100	95-100	35-50	15-25
	40-60	Silt loam, silty clay loam.	CL	A-7, A-6	0	0	100	100	100	95-100	35-50	15-25

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 10 inches	Frag- ments 3-10 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO			4	10	40	200		
	In				Pct	Pct					Pct	
50C2, 50D2---- Marshall	0-7	Silty clay loam.	CL	A-6, A-7	0	0	100	100	100	95-100	35-50	15-25
	7-14	Silty clay loam.	CL	A-6, A-7	0	0	100	100	100	95-100	35-50	15-25
	14-38	Silty clay loam.	CL	A-7, A-6	0	0	100	100	100	95-100	35-50	15-25
	38-60	Silt loam, silty clay loam.	CL	A-7, A-6	0	0	100	100	100	95-100	35-50	15-25
52------------ Motark	0-9	Silt loam-----	CL, CL-ML	A-4, A-6	0	0	100	100	90-100	70-90	25-40	5-15
	9-60	Silt loam-----	CL, CL-ML	A-4, A-6	0	0	100	100	90-100	70-90	25-40	5-15
54B----------- Monona	0-21	Silt loam-----	ML, CL	A-6, A-7	0	0	100	100	95-100	95-100	35-50	10-25
	21-46	Silt loam, silty clay loam.	ML, CL	A-6, A-7	0	0	100	100	95-100	95-100	35-50	10-25
	46-60	Silt loam-----	CL	A-6	0	0	100	100	95-100	95-100	30-40	10-20
54C2, 54D2---- Monona	0-9	Silt loam-----	ML, CL	A-6, A-7	0	0	100	100	95-100	95-100	35-50	10-25
	9-28	Silt loam, silty clay loam.	ML, CL	A-6, A-7	0	0	100	100	95-100	95-100	35-50	10-25
	28-60	Silt loam-----	CL	A-6	0	0	100	100	95-100	95-100	30-40	10-20
56------------ Dupo	0-8	Silt loam-----	ML, CL, CL-ML	A-4, A-6	0	0	100	100	100	95-100	20-35	1-15
	8-31	Silt loam-----	CL, CL-ML	A-4, A-6	0	0	100	100	100	95-100	20-35	5-15
	31-60	Silty clay, clay, silty clay loam.	CL, CH	A-7, A-6	0	0	100	100	100	98-100	35-55	15-30
57------------ Modale	0-30	Silt loam-----	CL, CL-ML	A-4, A-6	0	0	100	100	95-100	80-90	25-40	5-15
	30-60	Silty clay, clay.	CH	A-7	0	0	100	100	95-100	95-100	65-85	40-60
58B:												
Motark--------	0-8	Silt loam-----	CL, CL-ML	A-4, A-6	0	0	100	100	90-100	70-90	25-40	5-15
	8-60	Silt loam-----	CL, CL-ML	A-4, A-6	0	0	100	100	90-100	70-90	25-40	5-15
Napier--------	0-24	Silt loam-----	CL	A-4, A-6	0	0	100	100	95-100	95-100	25-40	8-20
	24-60	Silt loam-----	CL	A-4, A-6	0	0	100	100	95-100	95-100	25-40	8-20
59B:												
Nodaway-------	0-8	Silt loam-----	CL, CL-ML	A-4, A-6	0	0	100	95-100	95-100	90-100	25-35	5-15
	8-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	0	100	95-100	95-100	90-100	25-40	5-15
Judson--------	0-20	Silt loam-----	CL, CL-ML	A-4, A-6	0	0	100	100	100	95-100	25-35	5-15
	20-45	Silty clay loam.	CL	A-6, A-7	0	0	100	100	100	95-100	30-50	15-25
	45-60	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4	0	0	100	100	100	95-100	25-50	5-25
60------------ Nodaway	0-7	Silt loam-----	CL, CL-ML	A-4, A-6	0	0	100	95-100	95-100	90-100	25-35	5-15
	7-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	0	100	95-100	95-100	90-100	25-40	5-15

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 10 inches	Fragments 3-10 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct	Pct					Pct	
61B----------- Napier	0-31	Silt loam-----	CL	A-4, A-6	0	0	100	100	95-100	95-100	25-40	8-20
	31-60	Silt loam-----	CL	A-4, A-6	0	0	100	100	95-100	95-100	25-40	8-20
62B:												
Napier--------	0-24	Silt loam-----	CL	A-4, A-6	0	0	100	100	95-100	95-100	25-40	8-20
	24-60	Silt loam-----	CL	A-4, A-6	0	0	100	100	95-100	95-100	25-40	8-20
Gullied land.												
63------------ Leta	0-10	Silt loam-----	CL	A-6, A-7	0	0	100	100	95-100	70-90	30-45	10-20
	10-31	Silty clay loam, silty clay.	CL	A-6, A-7	0	0	100	100	95-100	90-95	35-50	20-35
	31-55	Stratified very fine sandy loam to silt loam.	CL, CL-ML	A-4, A-6	0	0	100	100	90-100	55-80	20-35	5-15
	55-60	Fine sand, loamy fine sand.	SM	A-2-4	0	0	100	100	60-80	20-30	---	NP
64, 65-------- Leta	0-19	Silty clay----	CL, CH	A-7	0	0	100	100	95-100	95-100	45-65	30-45
	19-28	Silty clay loam, silty clay.	CL, CH	A-6, A-7	0	0	100	100	95-100	90-100	35-65	20-40
	28-60	Stratified silt loam to sandy loam.	CL-ML, CL	A-4, A-6	0	0	100	100	80-100	51-95	20-35	5-15
66------------ Leta	0-8	Silty clay----	CL, CH	A-7	0	0	100	100	95-100	90-95	45-65	30-45
	8-22	Silty clay loam, silty clay.	CL	A-6, A-7	0	0	100	100	95-100	90-95	35-50	20-35
	22-51	Stratified very fine sandy loam to silt loam.	CL, CL-ML	A-4, A-6	0	0	100	100	90-100	55-80	20-35	5-15
	51-60	Fine sand, loamy fine sand.	SM	A-2-4	0	0	100	100	60-80	20-30	---	NP
74------------ Sarpy	0-7	Loamy fine sand.	SM	A-2-4	0	0	100	100	60-80	15-35	---	NP
	7-60	Fine sand, loamy fine sand, sand.	SM, SP, SP-SM	A-2-4, A-3	0	0	100	100	60-80	2-35	---	NP
75------------ Sarpy	0-10	Fine sand-----	SM, SP-SM, SP	A-2-4, A-3	0	0	100	100	60-80	2-15	---	NP
	10-60	Fine sand, loamy fine sand, sand.	SM, SP, SP-SM	A-2-4, A-3	0	0	100	100	60-80	2-35	---	NP
78D2---------- Shelby	0-8	Clay loam-----	CL	A-6, A-7	0	0	90-95	85-95	75-90	55-70	35-45	15-25
	8-39	Clay loam-----	CL	A-6, A-7	0	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	39-60	Clay loam-----	CL	A-6, A-7	0	0-5	90-95	85-95	75-90	55-70	30-45	15-25
79F:												
Timula--------	0-30	Silt loam-----	ML	A-4	0	0	100	100	95-100	85-100	25-35	NP-10
	30-60	Silt loam, silt.	ML	A-4	0	0	100	100	95-100	85-100	25-35	NP-10

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 10 inches	Fragments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct	Pct					Pct	
79F:												
Knox----------	0-7	Silt loam-----	CL-ML, CL, ML	A-4, A-6	0	0	100	100	95-100	90-100	20-35	2-15
	7-39	Silty clay loam, silt loam.	CL	A-7	0	0	100	100	95-100	95-100	40-50	20-30
	39-60	Silt loam-----	CL	A-6, A-7	0	0	100	100	95-100	90-100	30-45	10-25
80G:												
Timula--------	0-20	Silt loam-----	ML	A-4	0	0	100	100	95-100	85-100	25-35	NP-10
	20-60	Silt loam, silt.	ML	A-4	0	0	100	100	95-100	85-100	25-35	NP-10
Hamburg-------	0-4	Silt loam-----	CL-ML, ML	A-4	0	0	100	100	100	95-100	<25	NP-5
	4-60	Silt loam, very fine sandy loam, silt.	CL-ML, ML	A-4	0	0	100	100	100	95-100	<25	NP-5
81------------- Wabash	0-34	Silty clay----	CH	A-7	0	0	100	100	100	95-100	50-75	30-50
	34-60	Silty clay, clay.	CH	A-7	0	0	100	100	100	95-100	52-78	30-55
82------------- Zook	0-24	Silty clay loam.	CH, CL	A-7	0	0	100	100	95-100	95-100	45-65	20-35
	24-44	Silty clay, silty clay loam.	CH	A-7	0	0	100	100	95-100	95-100	60-85	35-55
	44-60	Silty clay loam, silty clay, silt loam.	CH, CL, ML, MH	A-7, A-6	0	0	100	100	95-100	95-100	35-80	10-50
84. Udifluvents												
85. Pits												

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
14----------------- Blencoe	0-20	40-55	1.30-1.35	0.06-0.2	0.12-0.14	6.1-7.3	High---------	0.28	5	4	3-4
	20-28	35-50	1.30-1.35	0.06-0.2	0.18-0.20	6.6-7.8	High---------	0.43			
	28-60	18-24	1.35-1.40	0.6-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.43			
156---------------- Vanmeter	0-7	24-27	1.35-1.50	0.2-0.6	0.14-0.16	6.1-8.4	Moderate-----	0.32	2	8	1-2
	7-10	27-40	1.30-1.40	0.2-0.6	0.14-0.16	6.1-8.4	Moderate-----	0.43			
	10-22	40-60	1.50-1.60	<0.06	0.12-0.14	6.1-8.4	High---------	0.32			
	22-60	---	---	<0.06	---	---	-------------	----			
16----------------- Colo	0-27	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7	4-6
	27-50	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.28			
	50-60	25-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.28			
18B:											
Kenridge--------	0-45	27-32	1.28-1.32	0.2-0.6	0.21-0.23	5.6-6.5	Moderate-----	0.28	5	7	2-4
	45-60	27-35	1.28-1.35	0.2-0.6	0.18-0.20	6.1-7.3	Moderate-----	0.32			
Judson----------	0-24	24-27	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Low----------	0.28	5	6	2-4
	24-60	30-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.43			
20D2--------------- Contrary	0-5	20-27	1.25-1.35	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.32	5	6	2-4
	5-46	18-30	1.30-1.40	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.43			
	46-60	16-25	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.43			
22----------------- Dockery	0-9	15-27	1.20-1.45	0.6-2.0	0.22-0.24	6.1-7.3	Low----------	0.37	5	6	2-4
	9-49	18-32	1.20-1.45	0.6-2.0	0.18-0.22	5.6-7.3	Moderate-----	0.43			
	49-60	40-60	1.30-1.45	<0.06	0.12-0.14	5.6-7.3	High---------	0.28			
26----------------- Grable	0-8	10-20	1.20-1.40	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.32	4	3	1-2
	8-18	12-16	1.25-1.50	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.43			
	18-60	2-10	1.20-1.50	6.0-20	0.02-0.07	7.4-8.4	Low----------	0.15			
27:											
Grable----------	0-8	10-20	1.20-1.30	0.6-2.0	0.22-0.24	7.4-8.4	Low----------	0.32	4	3	1-2
	8-24	10-20	1.20-1.40	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.43			
	24-40	5-10	1.20-1.40	6.0-20	0.04-0.08	7.4-8.4	Low----------	0.17			
	40-60	5-20	1.20-1.40	2.0-6.0	0.08-0.20	7.4-8.4	Low----------	0.32			
Leta------------	0-18	40-48	1.30-1.50	0.06-0.2	0.12-0.14	6.6-7.8	High---------	0.28	5	4	2-4
	18-33	35-48	1.30-1.50	0.06-0.2	0.11-0.19	7.4-7.8	High---------	0.28			
	33-60	10-27	1.30-1.50	0.6-2.0	0.14-0.22	7.4-8.4	Low----------	0.28			
28----------------- Gilliam	0-12	15-20	1.25-1.40	0.6-2.0	0.20-0.24	6.6-8.4	Moderate-----	0.28	5	4L	2-4
	12-23	15-35	1.30-1.45	0.6-2.0	0.17-0.22	7.4-8.4	Moderate-----	0.28			
	23-60	12-35	1.30-1.45	0.6-2.0	0.17-0.22	7.4-8.4	Moderate-----	0.28			
29----------------- Grable	0-8	10-20	1.20-1.40	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.32	4	3	1-2
	8-30	12-16	1.25-1.50	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.43			
	30-60	2-10	1.20-1.50	6.0-20	0.02-0.07	7.4-8.4	Low----------	0.15			
30, 32------------- Haynie	0-8	15-25	1.20-1.35	0.6-2.0	0.18-0.23	6.6-8.4	Low----------	0.32	5	4L	1-2
	8-60	15-18	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	Low----------	0.43			
34D2--------------- Exira	0-10	28-34	1.25-1.35	0.6-2.0	0.21-0.23	5.6-6.5	Moderate-----	0.32	5	7	2-3
	10-36	25-35	1.30-1.35	0.6-2.0	0.18-0.20	5.6-6.5	Moderate-----	0.43			
	36-60	20-30	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.43			

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
36B, 36D3, 36E3-- Timula	0-5	10-18	1.30-1.60	0.6-2.0	0.20-0.24	6.1-7.8	Low----------	0.37	5-4	5	1-2
	5-60	10-18	1.40-1.60	0.6-2.0	0.18-0.20	7.4-8.4	Low----------	0.37			
40:											
Kenmoor----------	0-10	10-20	1.40-1.50	2.0-6.0	0.13-0.16	6.6-8.4	Low----------	0.24	4	3	<1
	10-27	5-10	1.50-1.60	>6.0	0.05-0.12	7.4-8.4	Low----------	0.17			
	27-60	35-60	1.30-1.50	0.06-0.2	0.12-0.19	7.4-8.4	High---------	0.32			
Grable----------	0-8	10-20	1.20-1.30	0.6-2.0	0.22-0.24	7.4-8.4	Low----------	0.32	4	3	1-2
	8-24	10-20	1.20-1.40	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.43			
	24-35	5-10	1.20-1.40	6.0-20	0.04-0.08	7.4-8.4	Low----------	0.17			
	35-60	5-20	1.20-1.40	2.0-6.0	0.08-0.20	7.4-8.4	Low----------	0.32			
42C2, 42D2------- Knox	0-8	27-30	1.20-1.30	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.32	5-4	7	2-3
	8-47	25-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	47-60	18-27	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.43			
42E2, 42F-------- Knox	0-12	18-27	1.20-1.30	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.32	5	6	2-3
	12-45	25-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	45-60	18-27	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.43			
44C2------------- Lamoni	0-8	27-40	1.45-1.50	0.2-0.6	0.17-0.21	5.1-7.3	Moderate-----	0.37	3	7	2-3
	8-48	38-50	1.55-1.65	<0.2	0.13-0.17	5.1-6.5	High---------	0.37			
	48-60	32-40	1.60-1.70	0.06-0.2	0.14-0.18	5.6-7.3	High---------	0.37			
46--------------- Luton	0-7	60-85	1.30-1.35	<0.06	0.12-0.14	6.6-7.8	High---------	0.28	5	4	2-4
	7-60	50-85	1.30-1.35	<0.06	0.12-0.14	6.6-7.8	High---------	0.28			
50B-------------- Marshall	0-19	27-35	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7	3-4
	19-40	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	40-60	22-30	1.30-1.40	0.6-2.0	0.20-0.22	6.6-7.3	Moderate-----	0.43			
50C2, 50D2------- Marshall	0-7	27-35	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	2-3
	7-14	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.32			
	14-38	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	38-60	22-30	1.30-1.40	0.6-2.0	0.20-0.22	6.6-7.3	Moderate-----	0.43			
52--------------- Motark	0-9	10-18	1.20-1.30	0.6-2.0	0.21-0.23	6.1-7.8	Low----------	0.32	5	5	1-2
	9-60	10-18	1.20-1.30	0.6-2.0	0.21-0.23	6.6-7.8	Low----------	0.32			
54B-------------- Monona	0-21	20-27	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.28	5	6	3-4
	21-46	24-30	1.30-1.35	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.43			
	46-60	18-24	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	Low----------	0.43			
54C2, 54D2------- Monona	0-9	20-27	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.32	5	6	2-3
	9-28	24-30	1.30-1.35	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.43			
	28-60	18-24	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	Low----------	0.43			
56--------------- Dupo	0-8	10-18	1.25-1.45	0.6-2.0	0.22-0.24	5.6-8.4	Low----------	0.37	4	5	1-2
	8-31	10-18	1.30-1.50	0.6-2.0	0.20-0.22	5.6-8.4	Low----------	0.37			
	31-60	35-45	1.35-1.60	0.06-0.2	0.08-0.19	6.6-7.8	High---------	0.37			
57--------------- Modale	0-30	10-18	1.20-1.30	0.6-2.0	0.21-0.23	6.6-8.4	Low----------	0.37	4	4L	1-2
	30-60	50-60	1.35-1.45	0.06-0.2	0.11-0.13	7.4-8.4	High---------	0.28			
58B:											
Motark----------	0-8	10-18	1.20-1.30	0.6-2.0	0.21-0.23	6.1-7.8	Low----------	0.32	5	5	1-2
	8-60	10-18	1.20-1.30	0.6-2.0	0.21-0.23	6.6-7.8	Low----------	0.32			
Napier----------	0-24	20-27	1.20-1.25	0.6-2.0	0.22-0.24	6.1-7.3	Low----------	0.28	5	6	3-4
	24-60	20-27	1.25-1.30	0.6-2.0	0.20-0.22	6.1-8.4	Low----------	0.43			

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
59B:											
Nodaway----------	0-8	18-27	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Low-----------	0.32	5	6	2-3
	8-60	18-30	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.43			
Judson-----------	0-20	24-27	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Low-----------	0.28	5	6	4-5
	20-45	30-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.43			
	45-60	25-32	1.35-1.45	0.6-2.0	0.21-0.23	6.1-7.8	Moderate-----	0.43			
60---------------	0-7	18-27	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Low-----------	0.32	5	6	2-3
Nodaway	7-60	18-30	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.43			
61B--------------	0-31	20-27	1.20-1.25	0.6-2.0	0.22-0.24	6.1-7.3	Low-----------	0.28	5	6	3-4
Napier	31-60	20-27	1.25-1.30	0.6-2.0	0.20-0.22	6.1-8.4	Low-----------	0.43			
62B:											
Napier-----------	0-24	20-27	1.20-1.25	0.6-2.0	0.22-0.24	6.1-7.3	Low-----------	0.28	5	6	3-4
	24-60	20-27	1.25-1.30	0.6-2.0	0.20-0.22	6.1-8.4	Low-----------	0.43			
Gullied land.											
63---------------	0-10	22-27	1.30-1.45	0.2-0.6	0.22-0.24	6.6-7.8	Moderate-----	0.28	5	4L	2-4
Leta	10-31	35-45	1.30-1.50	0.06-0.2	0.13-0.18	6.6-7.8	High----------	0.28			
	31-55	10-27	1.30-1.50	0.6-2.0	0.17-0.22	7.4-7.8	Low-----------	0.28			
	55-60	5-10	1.30-1.50	6.0-20	0.05-0.08	7.4-8.4	Low-----------	0.10			
64---------------	0-19	40-48	1.30-1.50	0.06-0.2	0.12-0.14	6.6-7.8	High----------	0.28	5	4	2-4
Leta	19-28	35-48	1.30-1.50	0.06-0.2	0.11-0.19	7.4-7.8	High----------	0.28			
	28-60	10-27	1.30-1.50	0.6-2.0	0.14-0.22	7.4-8.4	Low-----------	0.28			
65---------------	0-19	40-50	1.30-1.50	0.06-0.2	0.12-0.14	6.6-7.8	High----------	0.28	5	4	2-4
Leta	19-28	35-50	1.30-1.50	0.06-0.2	0.11-0.19	7.4-7.8	High----------	0.28			
	28-60	7-27	1.30-1.50	0.6-2.0	0.14-0.22	7.4-8.4	Low-----------	0.28			
66---------------	0-8	40-48	1.30-1.45	0.06-0.2	0.12-0.14	6.6-7.8	High----------	0.28	5	4	2-4
Leta	8-22	35-45	1.30-1.50	0.06-0.2	0.13-0.18	6.6-7.8	High----------	0.28			
	22-51	10-27	1.30-1.50	0.6-2.0	0.17-0.22	7.4-7.8	Low-----------	0.28			
	51-60	5-10	1.30-1.50	6.0-20	0.05-0.08	7.4-8.4	Low-----------	0.10			
74---------------	0-7	2-5	1.20-1.50	6.0-20	0.05-0.09	6.6-8.4	Low-----------	0.17	5	2	.5-1
Sarpy	7-60	2-5	1.20-1.50	6.0-20	0.05-0.09	6.6-8.4	Low-----------	0.15			
75---------------	0-10	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	Low-----------	0.15	5	1	<1
Sarpy	10-60	2-5	1.20-1.50	>6.0	0.05-0.09	7.4-8.4	Low-----------	0.15			
78D2-------------	0-8	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.32	5	6	2-3
Shelby	8-39	30-35	1.55-1.65	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.28			
	39-60	30-35	1.55-1.65	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
79F:											
Timula-----------	0-30	10-18	1.30-1.60	0.6-2.0	0.20-0.24	6.1-7.8	Low-----------	0.37	5-4	5	1-2
	30-60	10-18	1.40-1.60	0.6-2.0	0.18-0.20	7.4-8.4	Low-----------	0.37			
Knox-------------	0-7	18-27	1.20-1.30	0.6-2.0	0.22-0.24	5.6-7.3	Low-----------	0.32	5	6	1-2
	7-39	25-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	39-60	18-27	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low-----------	0.43			
80G:											
Timula-----------	0-20	10-18	1.30-1.60	0.6-2.0	0.20-0.24	6.1-7.8	Low-----------	0.37	5-4	5	1-2
	20-60	10-18	1.40-1.60	0.6-2.0	0.18-0.20	7.4-8.4	Low-----------	0.37			
Hamburg----------	0-4	6-12	1.20-1.30	0.6-2.0	0.20-0.24	6.6-8.4	Low-----------	0.43	5	4L	.5-2
	4-60	6-12	1.20-1.30	0.6-2.0	0.17-0.22	7.4-8.4	Low-----------	0.43			

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
81---------------- Wabash	0-34	40-46	1.25-1.45	0.00-0.06	0.12-0.14	5.1-7.3	Very high----	0.28	5	4	2-4
	34-60	40-60	1.20-1.45	0.00-0.06	0.08-0.12	5.1-7.8	Very high----	0.28			
82---------------- Zook	0-24	35-40	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	High---------	0.37	5	7	5-7
	24-44	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High---------	0.28			
	44-60	20-45	1.30-1.45	0.06-0.6	0.11-0.22	5.6-7.8	High---------	0.28			
84. Udifluvents											
85. Pits											

TABLE 17.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
14: Blencoe	D	Rare	---	---	1.5-3.0	Apparent	Nov-Jun	>60	---	High	High	Low.
15G: Vanmeter	C	None	---	---	>6.0	---	---	20-40	Soft	Moderate	High	Low.
16: Colo	B/D	Occasional	Very brief or brief.	Nov-May	1.0-3.0	Apparent	Nov-Jun	>60	---	High	High	Moderate.
18B:												
Kenridge	C	Occasional	Brief	Nov-May	3.0-5.0	Apparent	Nov-May	>80	---	High	Moderate	Low.
Judson	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Low.
20D2: Contrary	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
22: Dockery	C	Rare	---	---	2.0-3.0	Apparent	Nov-May	>60	---	High	Moderate	Low.
26: Grable	B	Frequent	Very brief	Nov-May	>6.0	---	---	>60	---	Low	Low	Low.
27:												
Grable	B	Rare	---	---	>6.0	---	---	>60	---	Low	Low	Low.
Leta	C	Rare	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	High	High	Low.
28: Gilliam	C	Rare	---	---	1.5-3.0	Apparent	Nov-Jun	>60	---	High	High	Low.
29: Grable	B	Rare	---	---	>6.0	---	---	>60	---	Low	Low	Low.
30: Haynie	B	Frequent	Brief or long.	Nov-Jun	>6.0	---	---	>60	---	High	Low	Low.
32: Haynie	B	Rare	---	---	>6.0	---	---	>60	---	High	Low	Low.
34D2: Exira	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
36B, 36D3, 36E3--- Timula	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
40:												
Kenmoor----------	B	Rare--------	---	---	2.5-3.0	Perched	Nov-Jun	>60	---	Moderate	High-----	Low.
Grable-----------	B	Rare--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
42C2, 42D2, 42E2, 42F-------------- Knox	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
44C2-------------- Lamoni	C	None--------	---	---	1.0-3.0	Perched	Nov-May	>60	---	Moderate	High-----	Moderate.
46---------------- Luton	D	Rare--------	---	---	1.0-3.0	Apparent	Nov-May	>60	---	Moderate	High-----	Low.
50B, 50C2, 50D2--- Marshall	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
52---------------- Motark	B	Rare--------	---	Nov-Jun	2.5-4.0	Apparent	Nov-Jun	>60	---	High-----	Low------	Low.
54B, 54C2, 54D2--- Monona	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
56---------------- Dupo	C	Rare--------	---	---	1.5-3.5	Apparent	Nov-Jun	>60	---	High-----	High-----	Moderate.
57---------------- Modale	C	Rare--------	---	---	1.5-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Low.
58B:												
Motark-----------	B	Occasional	Very brief or brief.	Nov-Jun	3.0-5.0	Apparent	Nov-Jun	>60	---	High-----	Low------	Low.
Napier-----------	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
59B:												
Nodaway----------	B	Occasional	Very brief or brief.	Nov-Jun	3.0-5.0	Apparent	Nov-May	>80	---	High-----	Moderate	Low.
Judson-----------	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Low.
60---------------- Nodaway	B	Occasional	Very brief or brief.	Nov-Jun	3.0-5.0	Apparent	Nov-May	>80	---	High-----	Moderate	Low.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
61B----------------- Napier	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
62B:												
Napier------------	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
Gullied land.												
63, 64------------ Leta	C	Rare---------	---	---	1.0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Low.
65----------------- Leta	C	Frequent----	Brief-----	Mar-Jun	1.0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Low.
66----------------- Leta	C	Rare---------	---	---	1.0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Low.
74----------------- Sarpy	A	Rare---------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
75----------------- Sarpy	A	Frequent----	Brief or long.	Nov-Jun	>6.0	---	---	>60	---	Low------	Low------	Low.
78D2-------------- Shelby	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
79F:												
Timula------------	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
Knox--------------	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
80G:												
Timula------------	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
Hamburg-----------	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
81----------------- Wabash	D	Rare---------	---	---	0-1.0	Apparent	Nov-Jun	>60	---	Moderate	High-----	Moderate.
82----------------- Zook	C/D	Occasional	Brief or long.	Nov-Jun	0-3.0	Apparent	Nov-Jun	>60	---	High-----	High-----	Moderate.
84. Udifluvents												
85. Pits												

TABLE 18.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Blencoe	Clayey over loamy, montmorillonitic, mesic Aquic Hapludolls
Colo	Fine-silty, mixed, mesic Cumulic Endoaquolls
Contrary	Fine-silty, mixed, mesic Dystric Eutrochrepts
Dockery	Fine-silty, mixed, nonacid, mesic Aquic Udifluvents
Dupo	Coarse-silty over clayey, mixed, nonacid, mesic Aquic Udifluvents
Exira	Fine-silty, mixed, mesic Typic Hapludolls
Gilliam	Fine-silty, mixed, mesic Fluvaquentic Hapludolls
Grable	Coarse-silty over sandy or sandy-skeletal, mixed (calcareous), mesic Mollic Udifluvents
Hamburg	Coarse-silty, mixed (calcareous), mesic Typic Udorthents
Haynie	Coarse-silty, mixed (calcareous), mesic Mollic Udifluvents
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
Kenmoor	Sandy over clayey, mixed (calcareous), mesic Oxyaquic Udifluvents
Kenridge	Fine-silty, mixed, mesic Cumulic Hapludolls
Knox	Fine-silty, mixed, mesic Mollic Hapludalfs
*Lamoni	Fine, montmorillonitic, mesic Aquic Argiudolls
Leta	Clayey over loamy, montmorillonitic, mesic Fluvaquentic Hapludolls
*Luton	Fine, montmorillonitic, mesic Vertic Haplaquolls
Marshall	Fine-silty, mixed, mesic Typic Hapludolls
Modale	Coarse-silty over clayey, mixed (calcareous), mesic Aquic Udifluvents
Monona	Fine-silty, mixed, mesic Typic Hapludolls
Motark	Coarse-silty, mixed, nonacid, mesic Oxyaquic Udifluvents
Napier	Fine-silty, mixed, mesic Cumulic Hapludolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Sarpy	Mixed, mesic Typic Udipsamments
*Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Timula	Coarse-silty, mixed, mesic Typic Eutrochrepts
Vanmeter	Fine, illitic, mesic Typic Eutrochrepts
Wabash	Fine, montmorillonitic, mesic Vertic Endoaquolls
Zook	Fine, montmorillonitic, mesic Vertic Endoaquolls

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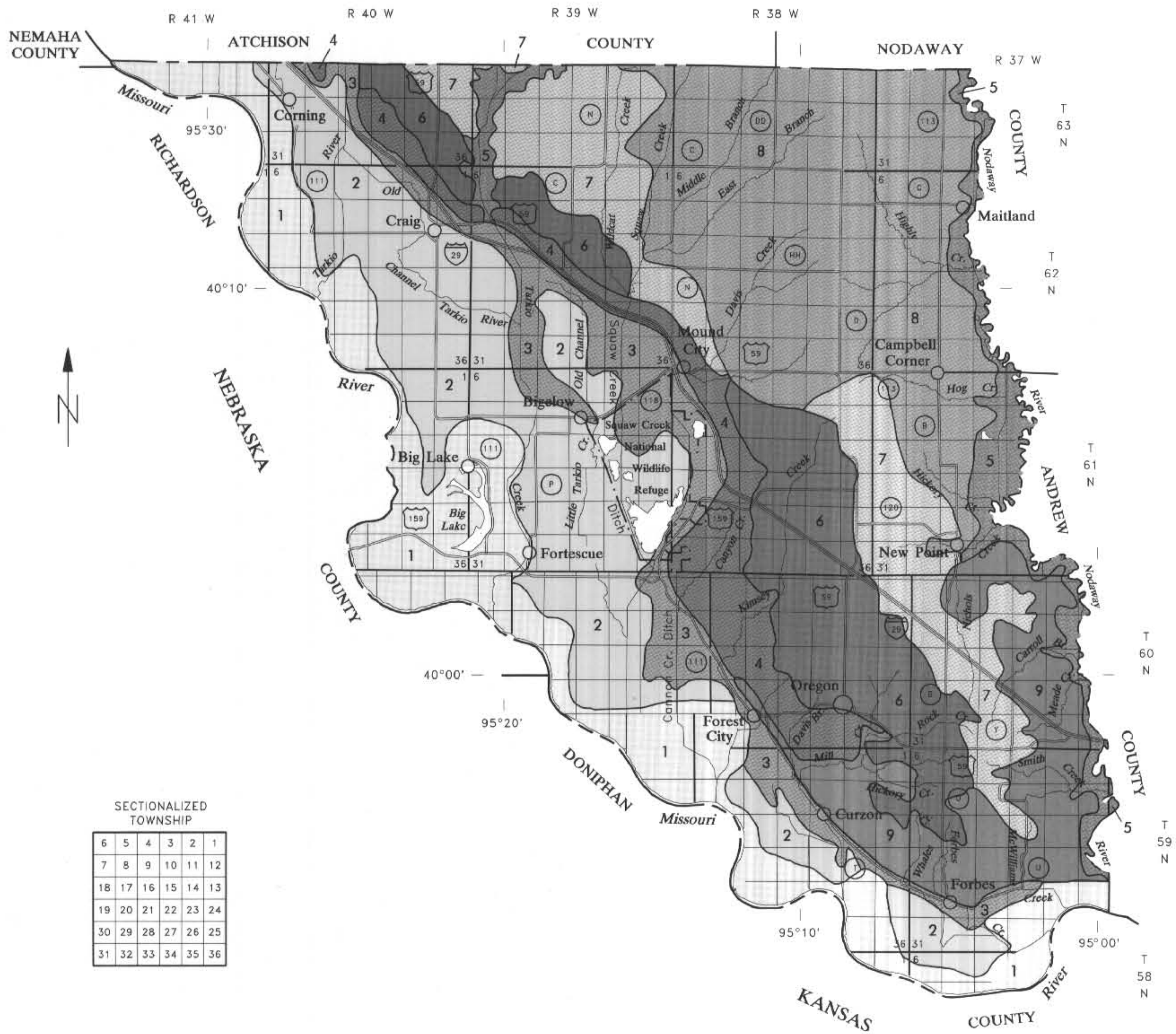

SOIL LEGEND*

1	LETA–GRABLE–HAYNIE ASSOCIATION
2	LUTON–WABASH–BLENCOE ASSOCIATION
3	MOTARK–DUPO–DOCKERY ASSOCIATION
4	TIMULA–MONONA–NAPIER ASSOCIATION
5	NODAWAY–COLO ASSOCIATION
6	MONONA–TIMULA–CONTRARY ASSOCIATION
7	MARSHALL–CONTRARY ASSOCIATION
8	MARSHALL–EXIRA–SHELBY ASSOCIATION
9	KNOX–VANMETER ASSOCIATION

*The units on this legend are described in the text under the heading "General Soil Map Units."

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UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI DEPARTMENT OF NATURAL RESOURCES
MISSOURI AGRICULTURAL EXPERIMENT STATION

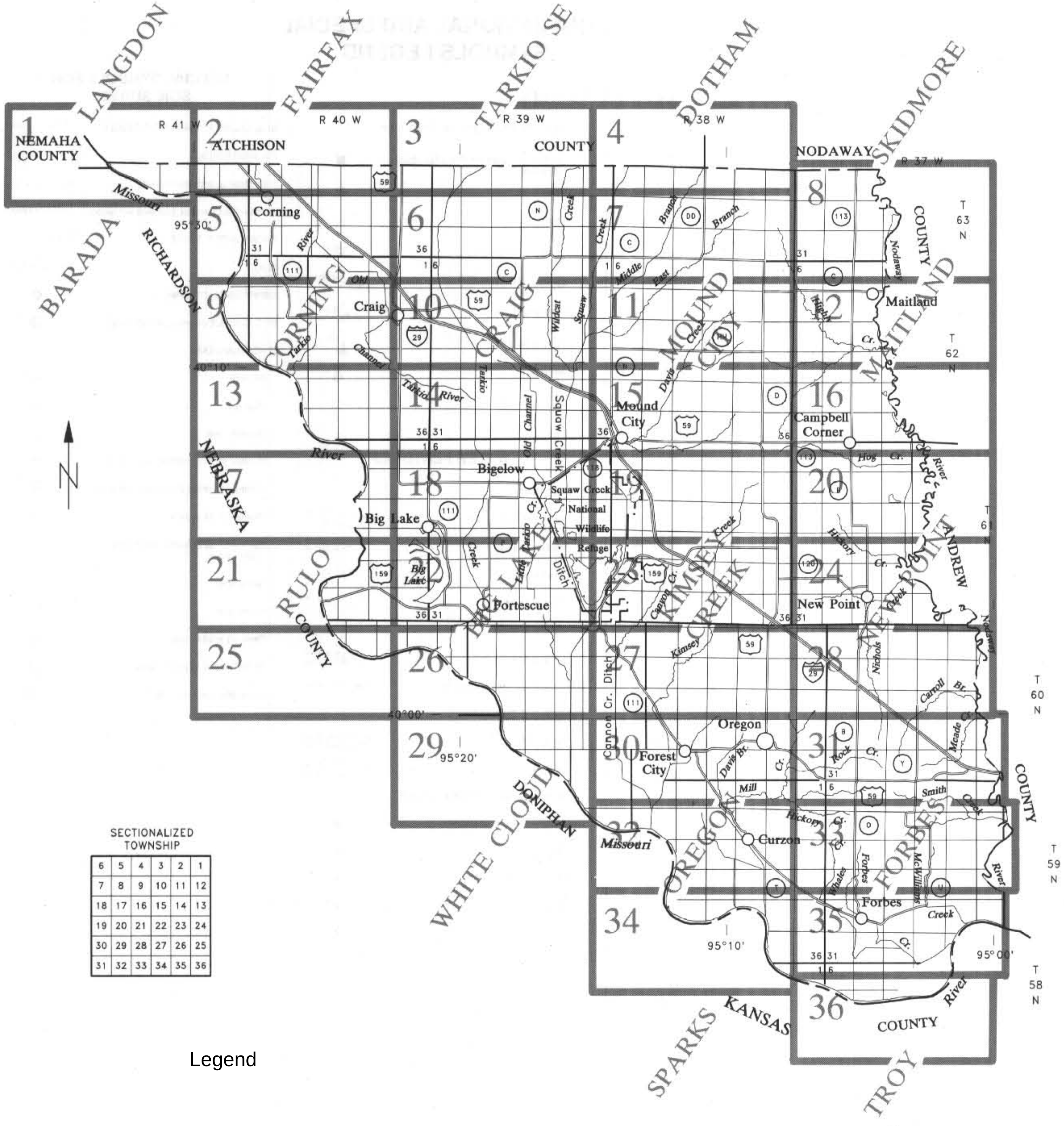
GENERAL SOIL MAP
HOLT COUNTY, MISSOURI

Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 4 8 Km

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



Legend

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General Soil Map

INDEX TO MAP SHEETS

HOLT COUNTY, MISSOURI

Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 4 8 Km

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils, map units of higher taxonomic placement, or miscellaneous areas. A final number of 2 following the slope letter indicates that the soil is moderately eroded, and 3 indicates that the soil is severely eroded.

SYMBOL	NAME
14	Blencoe silty clay, rarely flooded
15G	Vanmeter flaggy silt loam, 14 to 45 percent slopes
16	Colo silty clay loam, occasionally flooded
18B	Kenridge-Judson complex, 1 to 7 percent slopes
20D2	Contrary silt loam, 9 to 14 percent slopes, eroded
22	Dockery silt loam, clayey substratum, rarely flooded
26	Grable very fine sandy loam, frequently flooded
27	Grable-Leta complex, rarely flooded
28	Gilliam silt loam, rarely flooded
29	Grable very fine sandy loam, rarely flooded
30	Haynie silt loam, frequently flooded
32	Haynie silt loam, rarely flooded
34D2	Exira silty clay loam, 9 to 14 percent slopes, eroded
36B	Timula silt loam, 2 to 7 percent slopes
36D3	Timula silt loam, 9 to 14 percent slopes, severely eroded
36E3	Timula silt loam, 14 to 25 percent slopes, severely eroded
40	Kenmoor-Grable complex, rarely flooded
42C2	Knox silty clay loam, 5 to 9 percent slopes, eroded
42D2	Knox silty clay loam, 9 to 14 percent slopes, eroded
42E2	Knox silt loam, 14 to 20 percent slopes, eroded
42F	Knox silt loam, 20 to 35 percent slopes
44C2	Lamoni silty clay loam, 5 to 9 percent slopes, eroded
46	Luton clay, rarely flooded
50B	Marshall silty clay loam, 2 to 5 percent slopes
50C2	Marshall silty clay loam, 5 to 9 percent slopes, eroded
50D2	Marshall silty clay loam, 9 to 14 percent slopes, eroded
52	Motark silt loam, rarely flooded
54B	Monona silt loam, 2 to 5 percent slopes
54C2	Monona silt loam, 5 to 9 percent slopes, eroded
54D2	Monona silt loam, 9 to 14 percent slopes, eroded
56	Dupo silt loam, rarely flooded
57	Modale silt loam, rarely flooded
58B	Motark-Napier silt loams, 1 to 7 percent slopes
59B	Nodaway-Judson silt loams, 1 to 7 percent slopes
60	Nodaway silt loam, occasionally flooded
61B	Napier silt loam, 1 to 7 percent slopes
62B	Napier-Gullied land complex, 1 to 7 percent slopes
63	Leta silt loam, sandy substratum, rarely flooded
64	Leta silty clay, rarely flooded
65	Leta silty clay, frequently flooded
66	Leta silty clay, sandy substratum, rarely flooded
74	Sarpy loamy fine sand, rarely flooded
75	Sarpy fine sand, frequently flooded
78D2	Shelby clay loam, 9 to 14 percent slopes, eroded
79F	Timula-Knox silt loams, 14 to 35 percent slopes
80G	Timula-Hamburg silt loams, 14 to 90 percent slopes
81	Wabash silty clay, rarely flooded
82	Zook silty clay loam, occasionally flooded
84	Udifluvents, frequently flooded
85	Pits, quarries

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CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state, or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline and neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK
1 890 000 FEET

LAND DIVISION CORNER (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or Small > 3 acres

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban area) (occupied)
- Church
- School
- Indian mound (label)
- Located object (label)
- Tank (label)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial
- Intermittent

MISCELLANEOUS WATER FEATURES

- Marsh or swamp 2-5 acres
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

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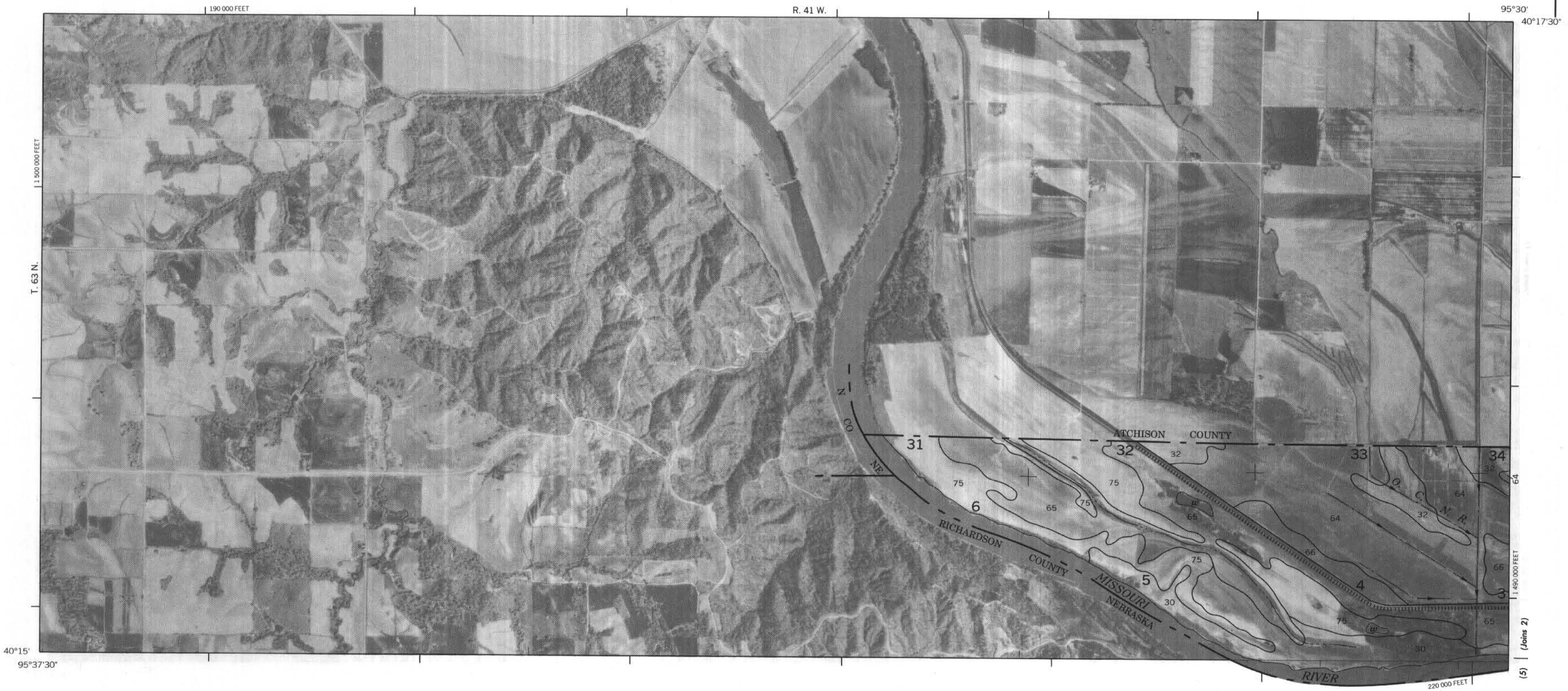

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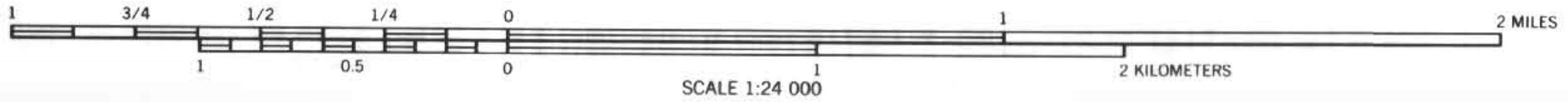

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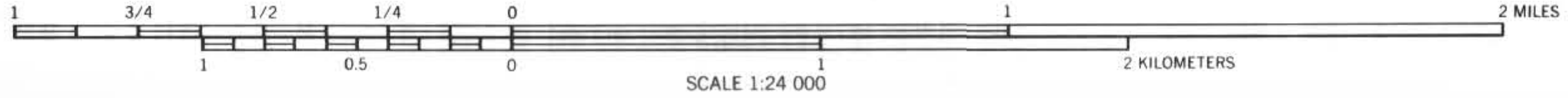

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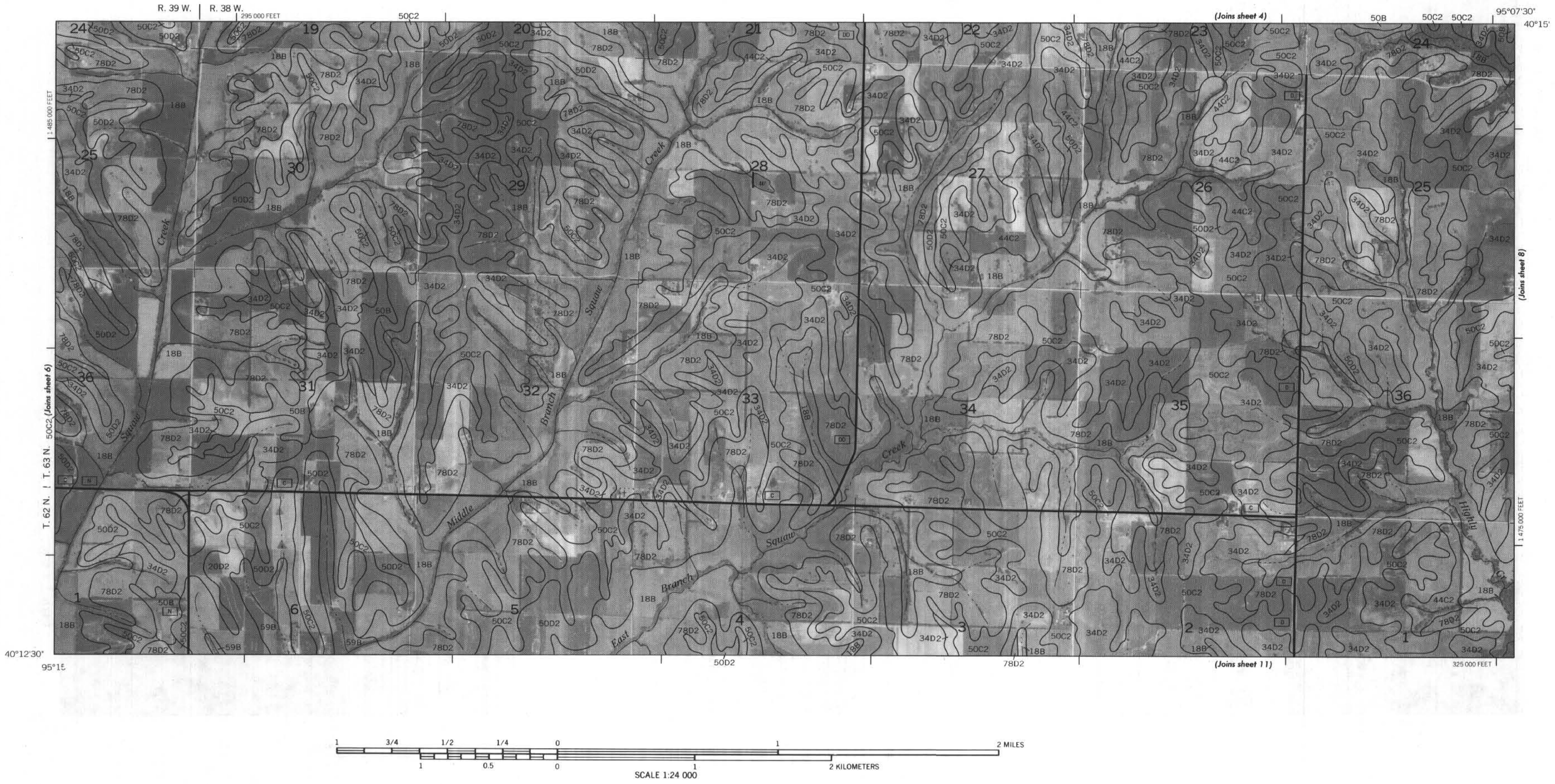

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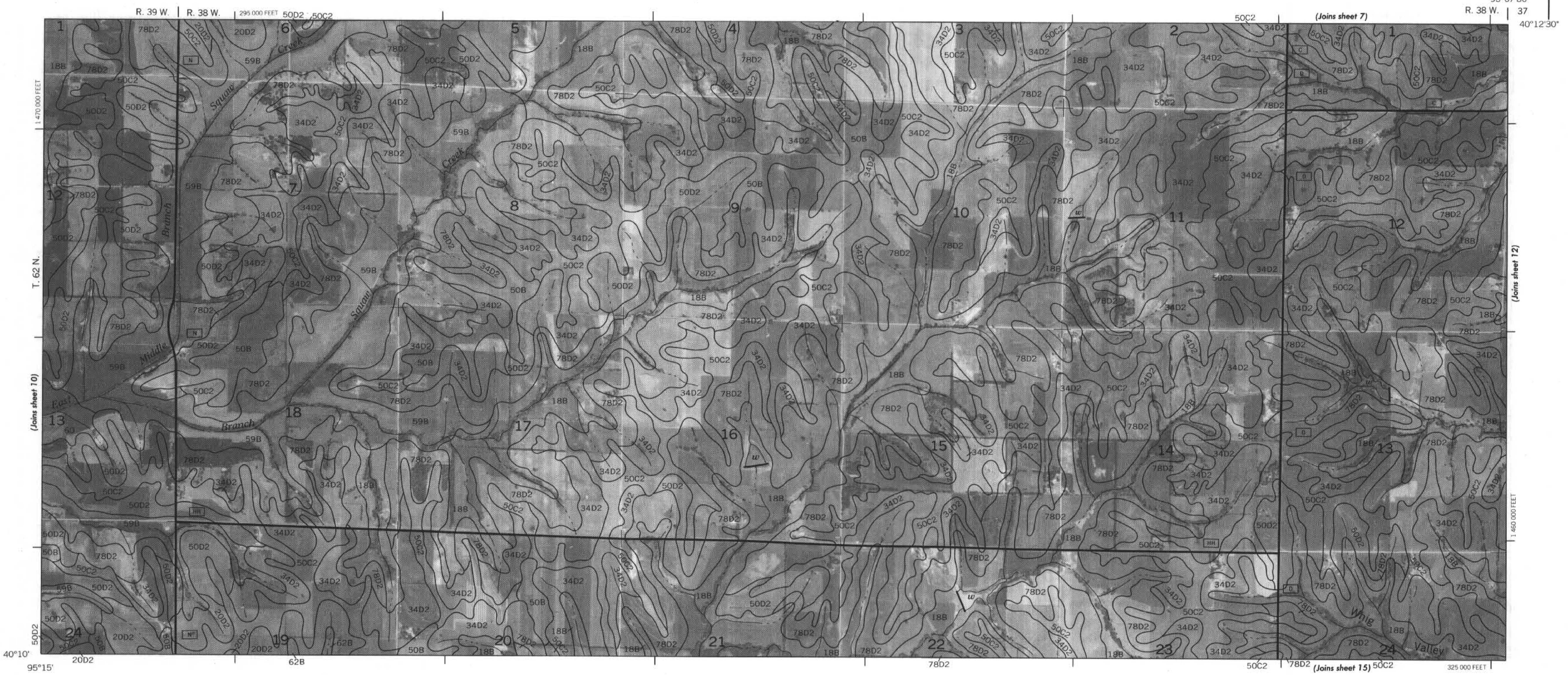

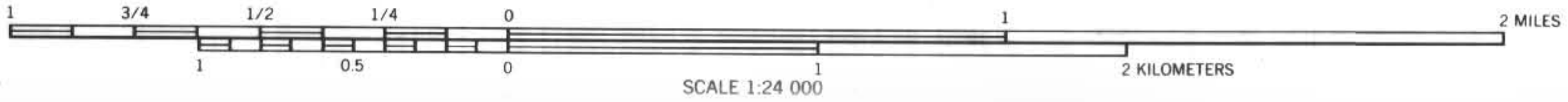

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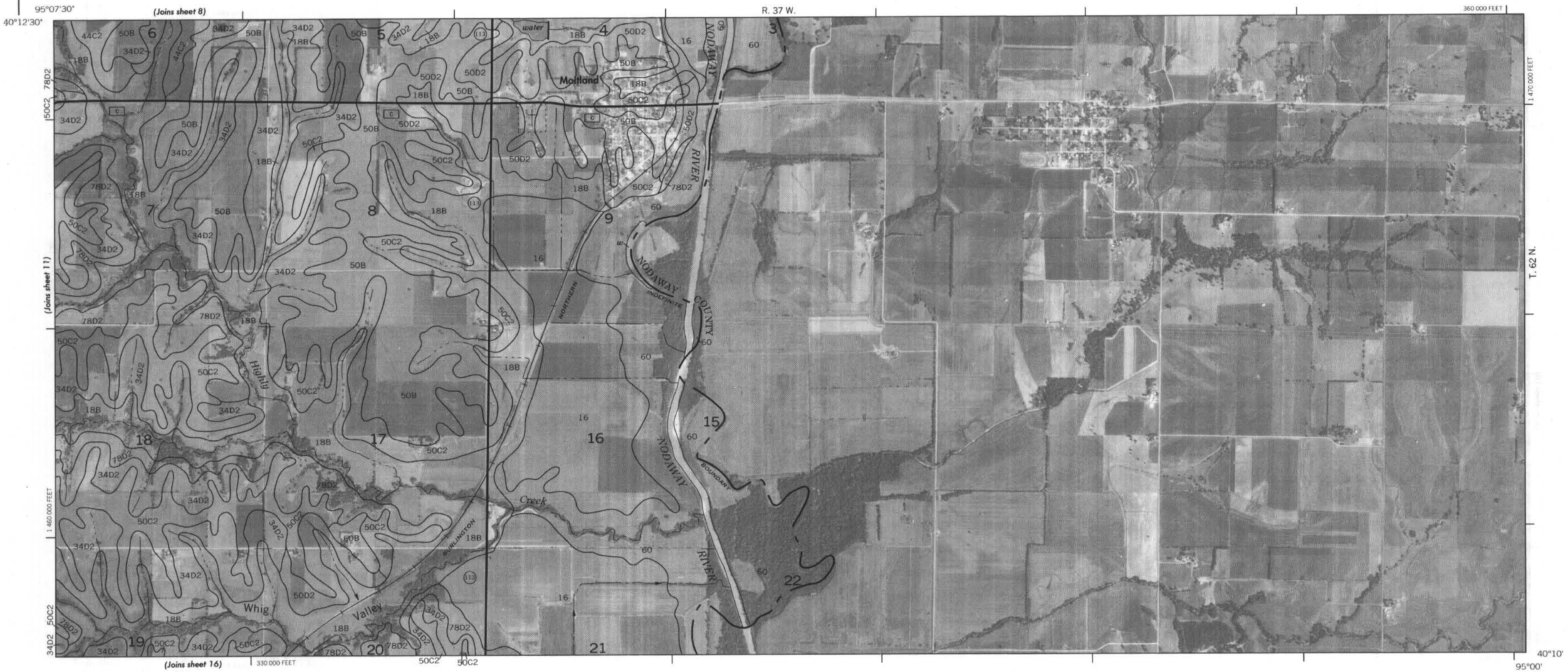

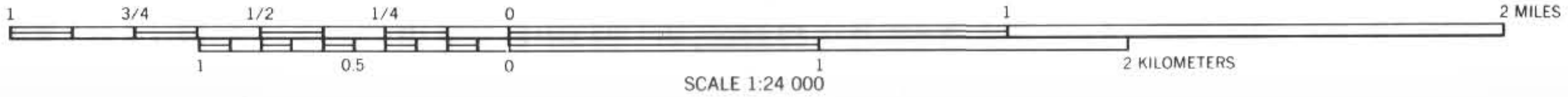

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N

95°22'30" 40°10' (Joins sheet 10) R. 40 W. | R. 39 W. 78D2 290 000 FEET

(Joins sheet 13) 1 445 000 FEET (Joins sheet 15) 1 455 000 FEET T. 62 N. T. 61 N.

(Joins sheet 18) 260 000 FEET 40°07'30" 95°15'

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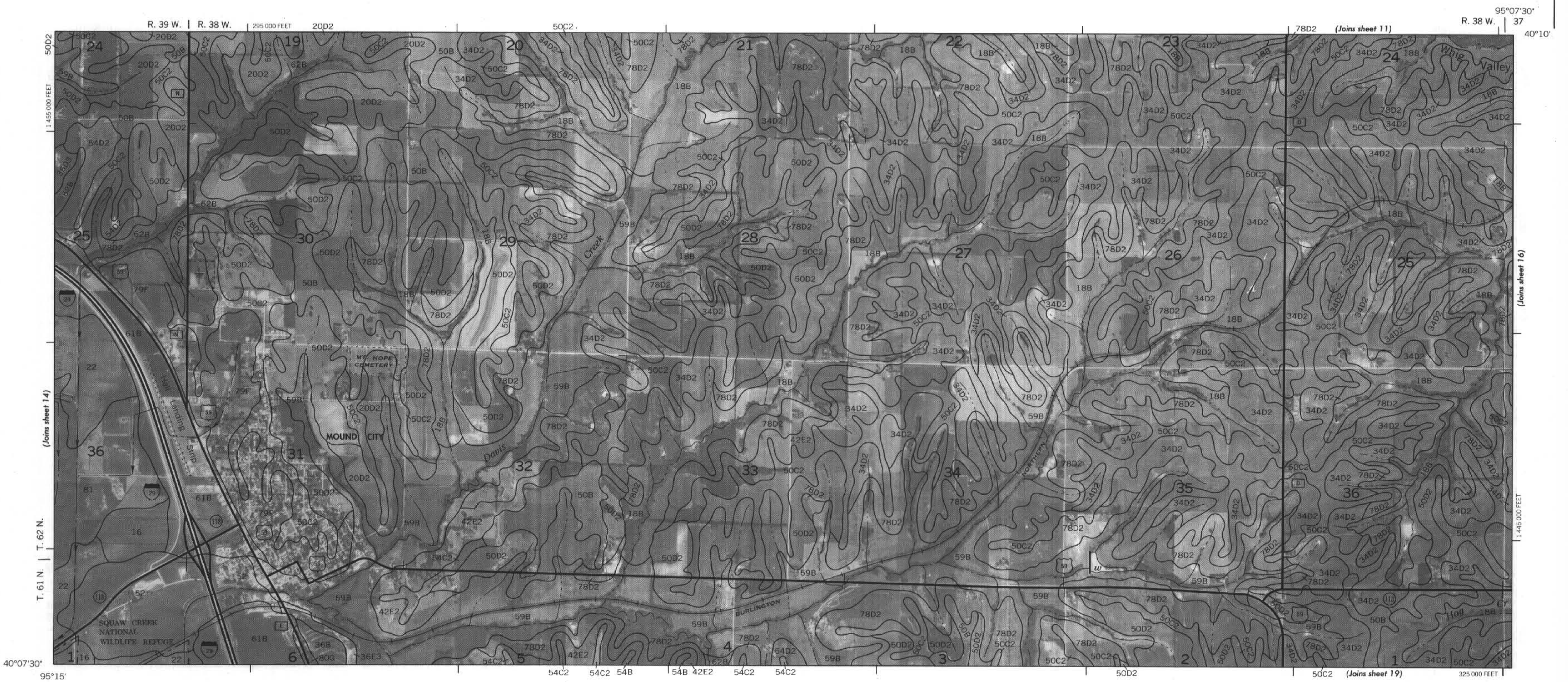

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1 0.5 0 1 2 KILOMETERS

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SCALE 1:24 000
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SCALE 1:24 000

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1 0.5 0 1 2 KILOMETERS

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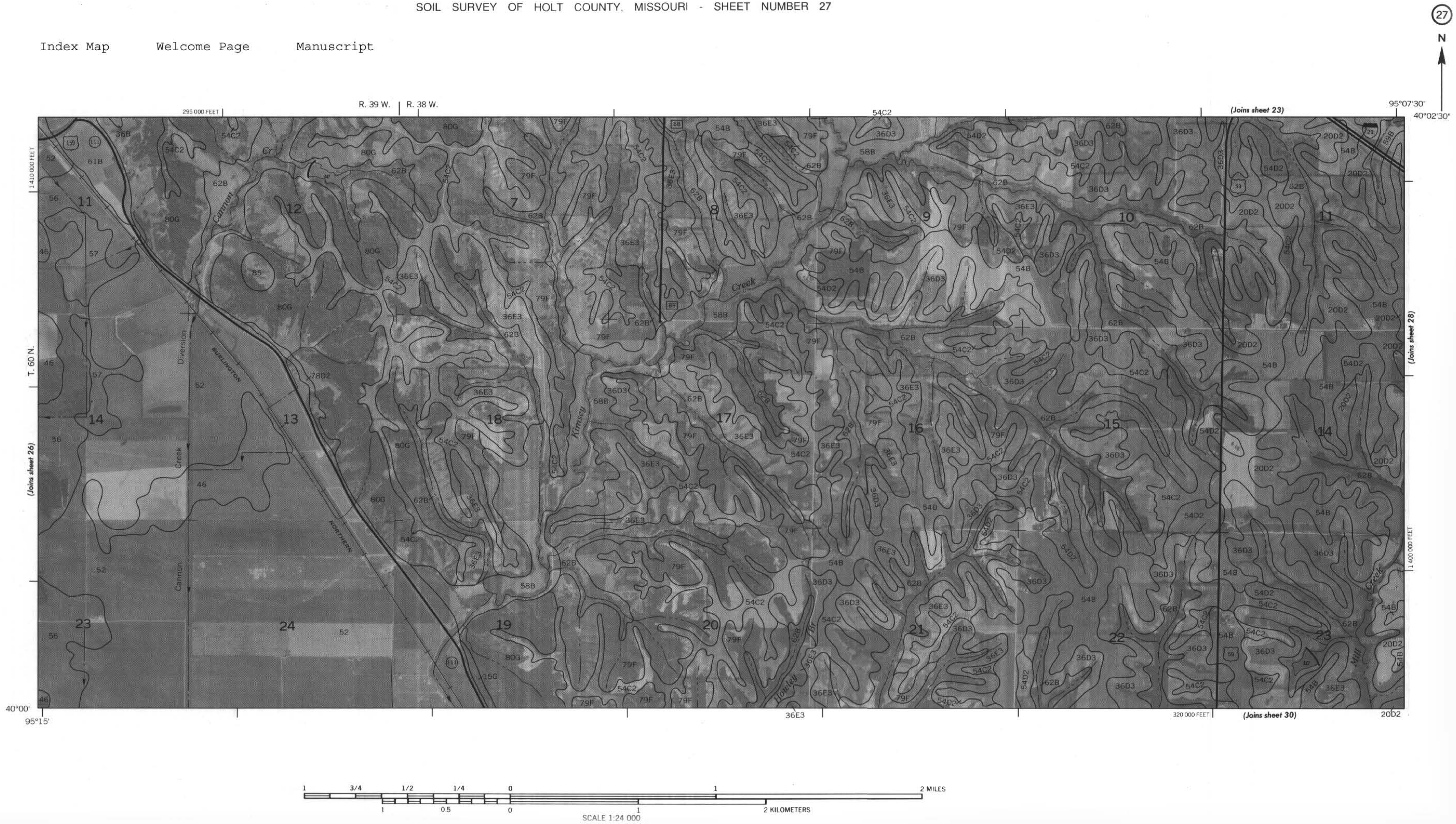

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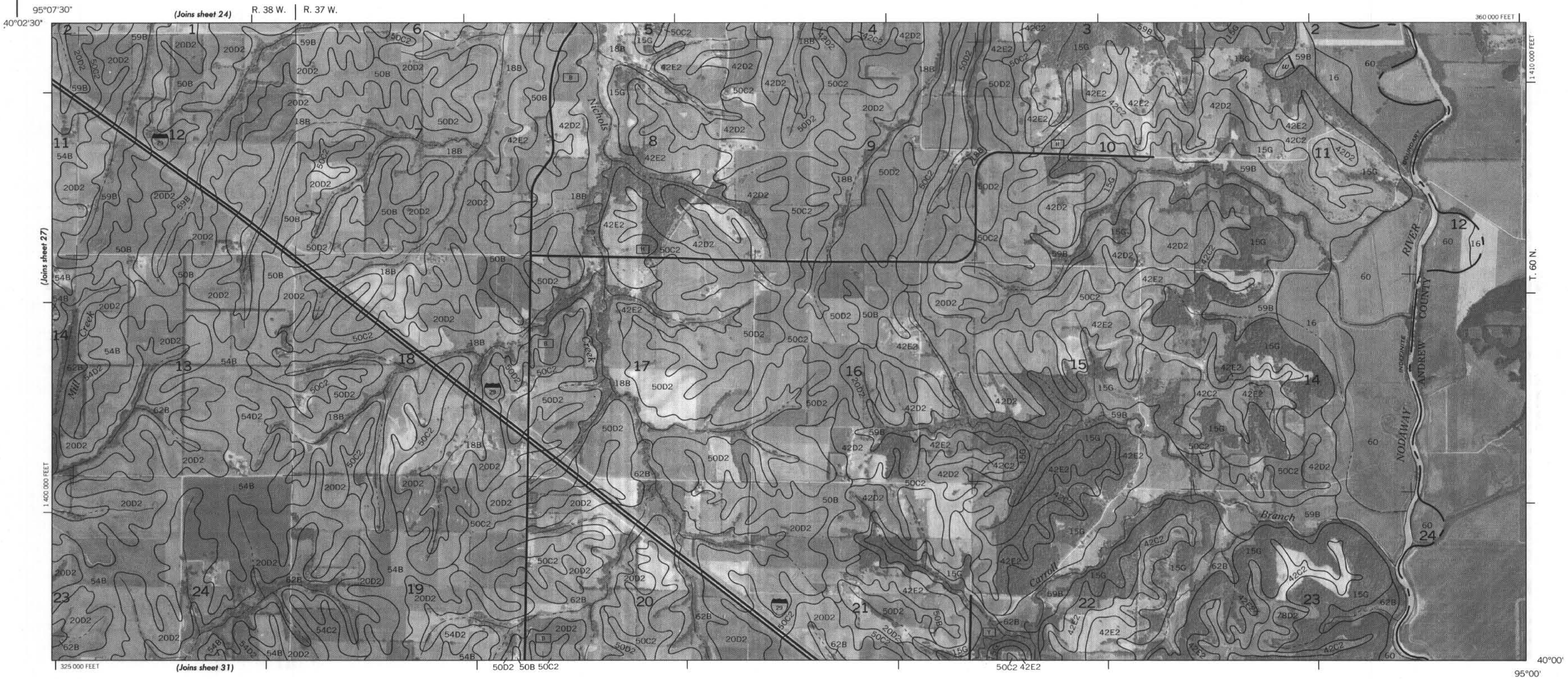

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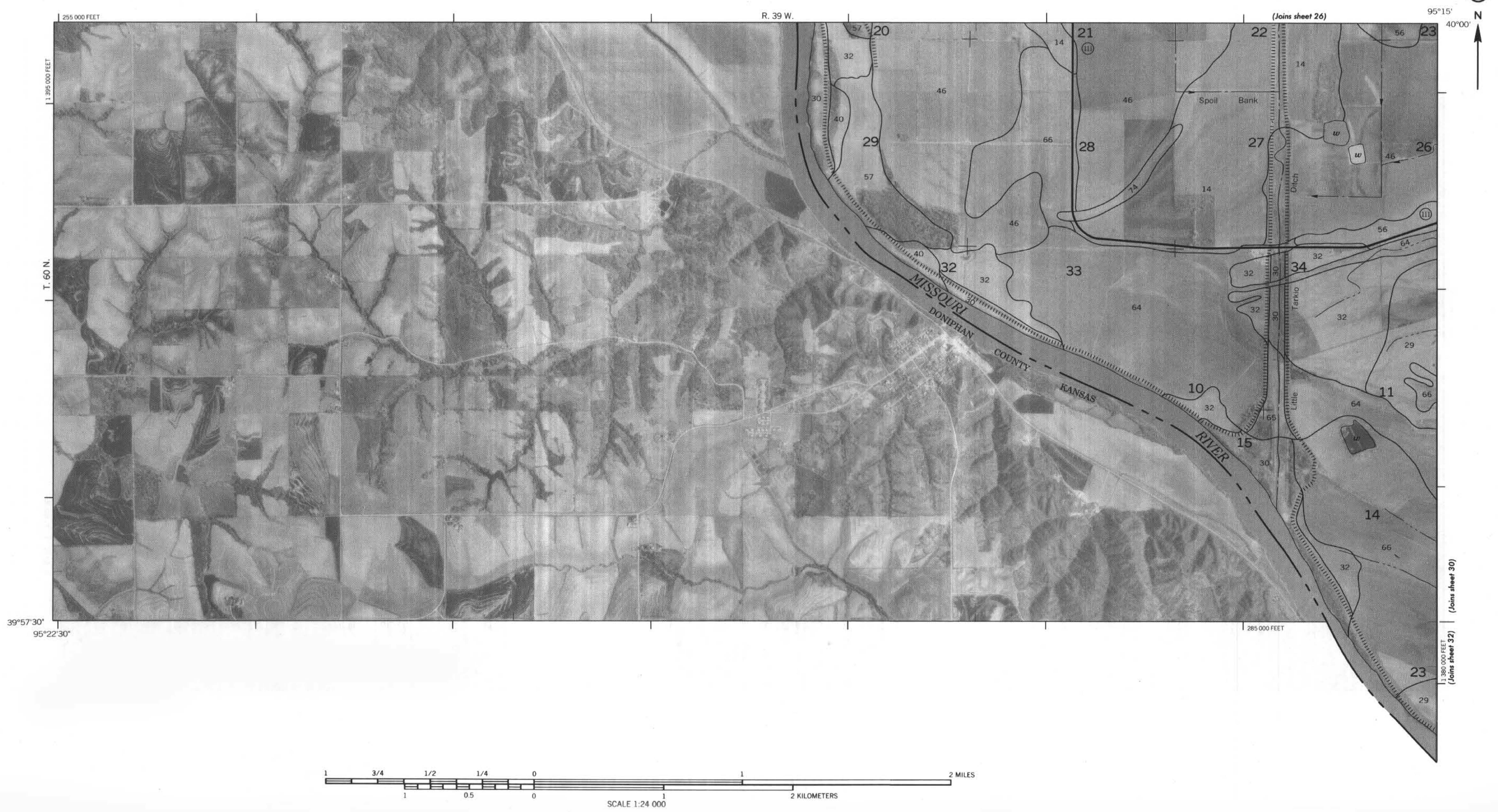

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1 0.5 0 1 2 KILOMETERS

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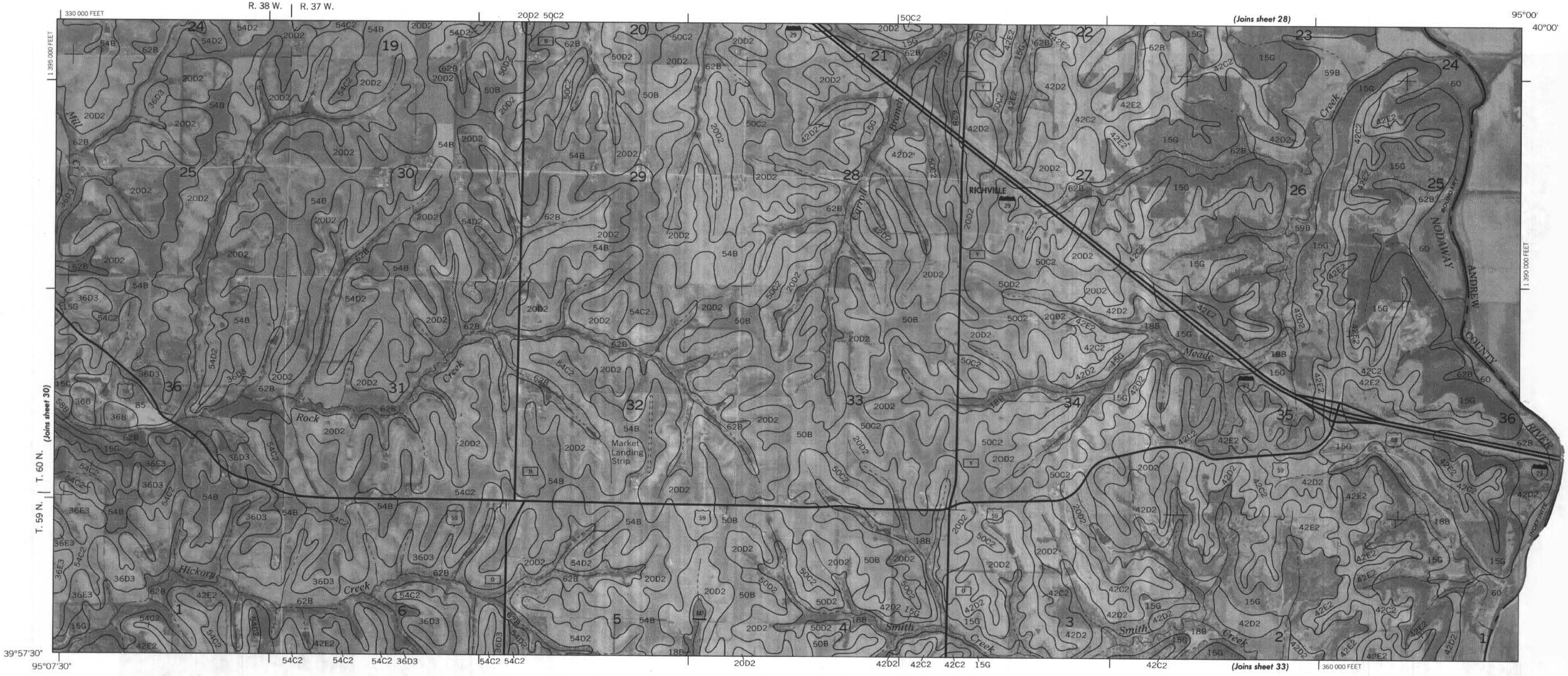

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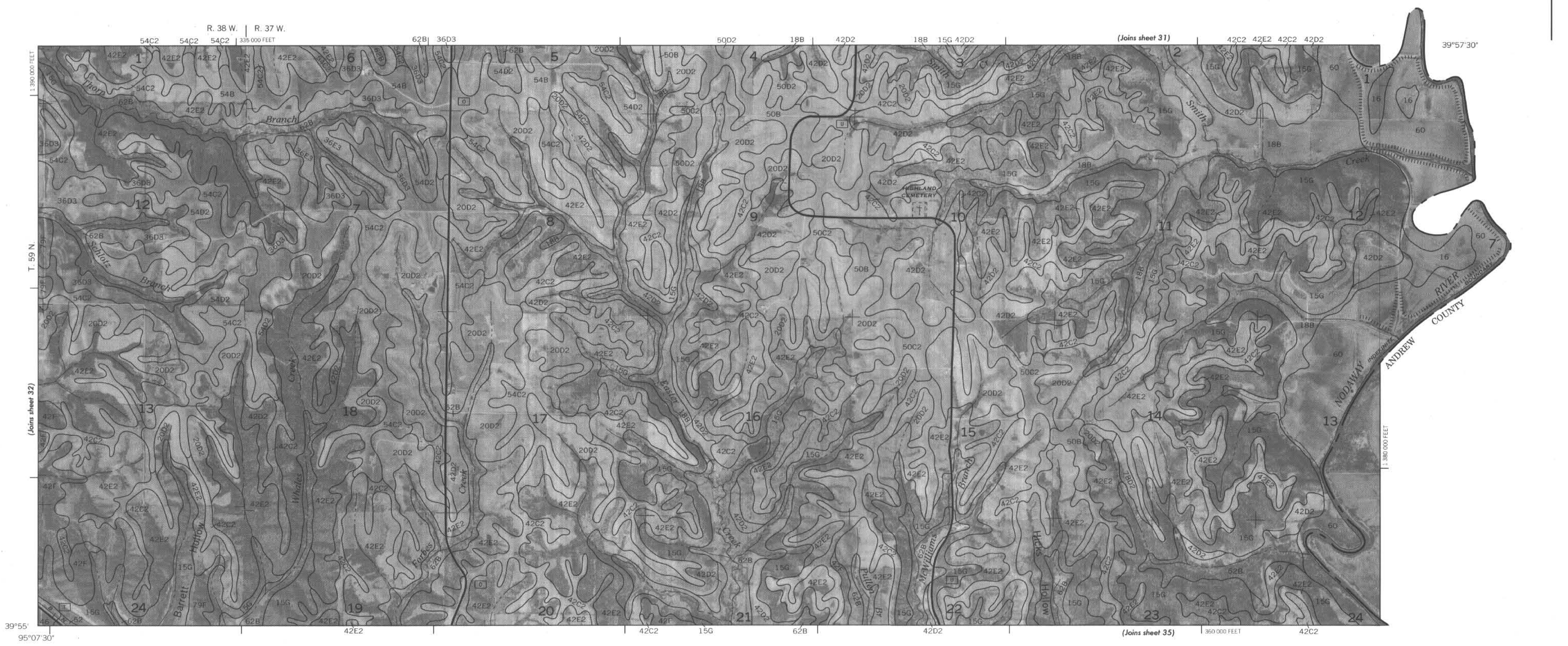

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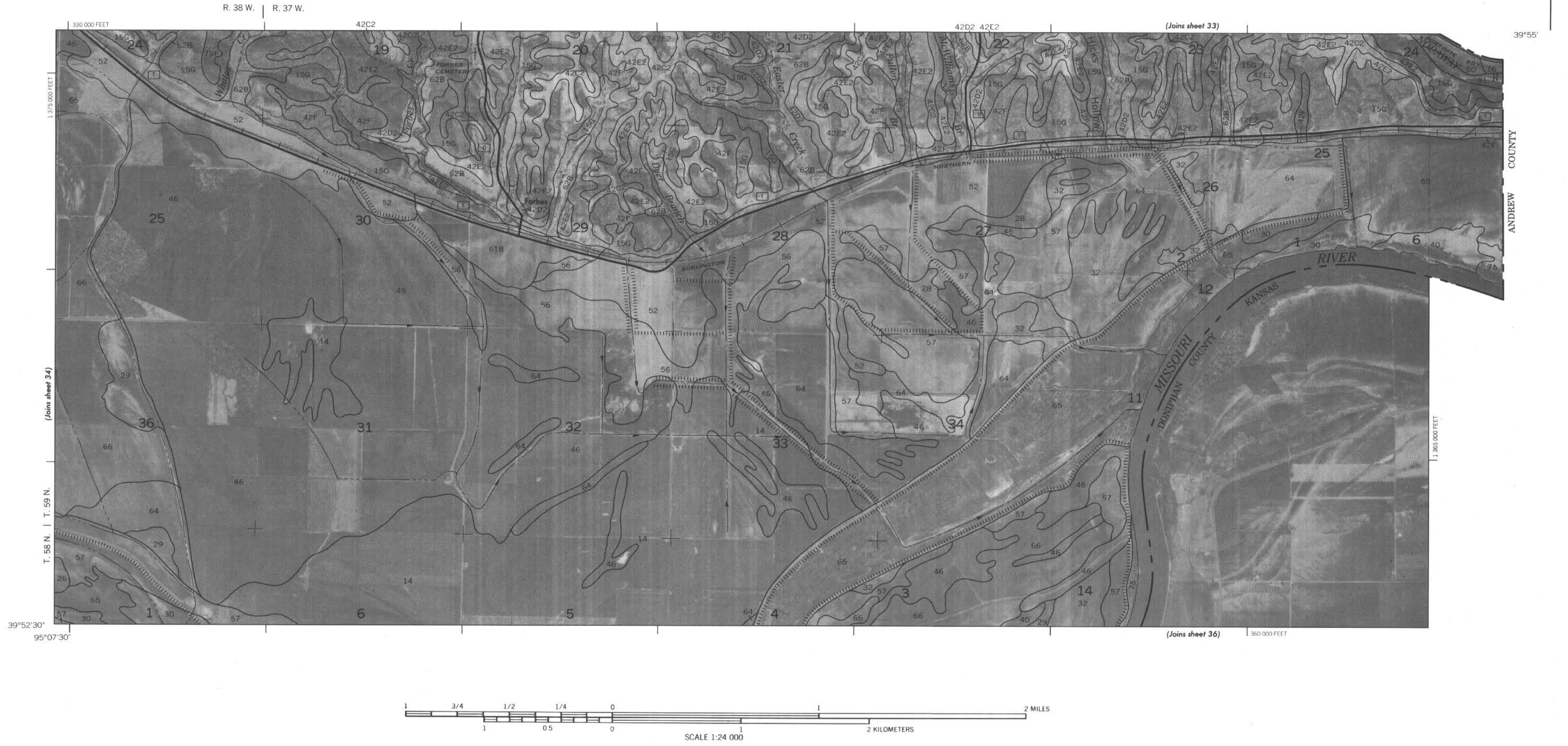

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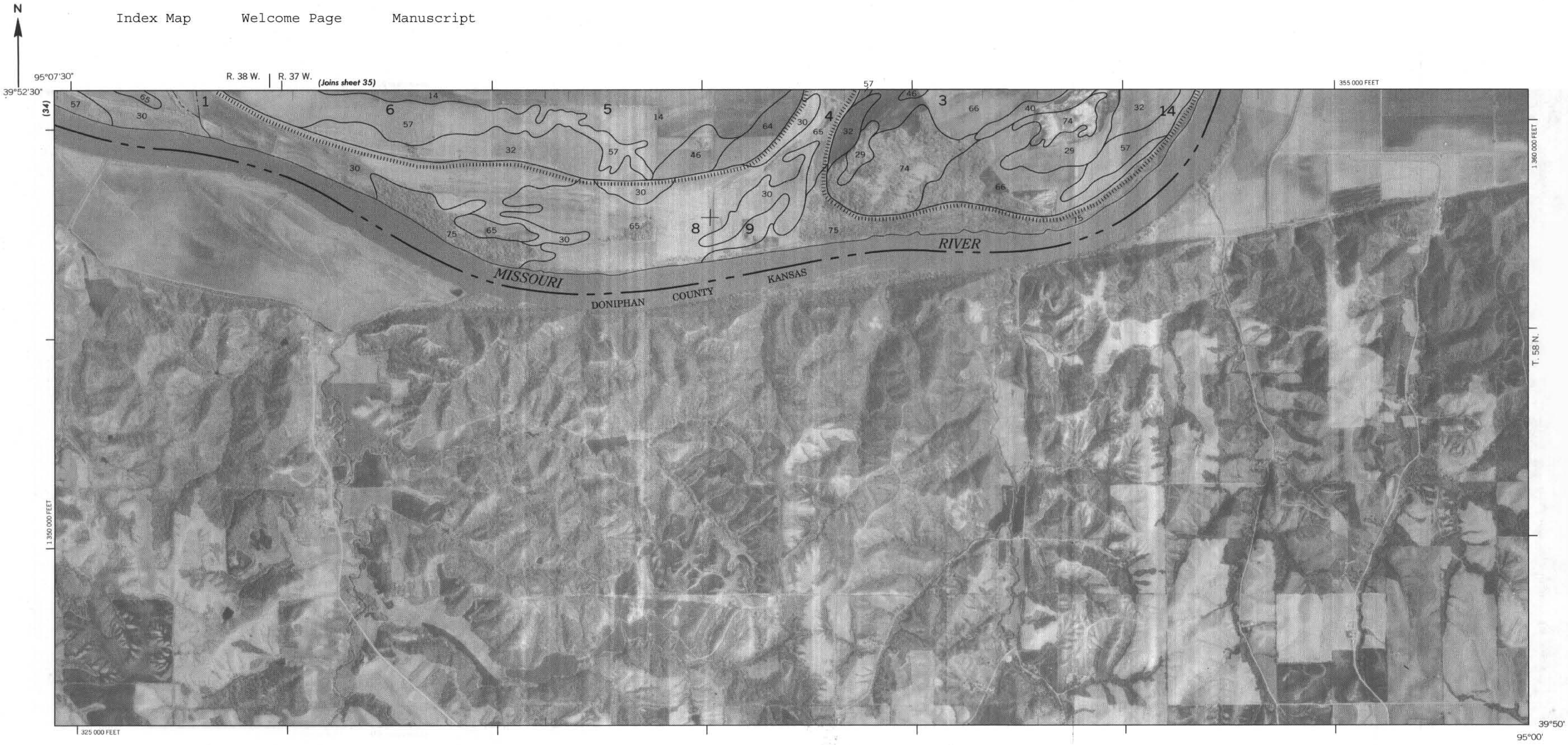

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